GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN IN PUBLICA COMMODA SEIT 1737

Amtliche Mitteilungen II

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Inhaltsverzeichnis

Herausgegeben von dem Präsidenten der Georg-August-Universität Göttingen

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Fakultät für Mathematik und Informatik:

Nach Beschluss des Fakultätsrats der Fakultät für Mathematik und Informatik vom 10.01.2024 hat das Präsidium der Georg-August-Universität Göttingen am 31.01.2024 die Neufassung des Modulverzeichnisses zur Prüfungs- und Studienordnung für den Bachelor-Studiengang „Mathematical Data Science“ genehmigt (§ 44 Abs. 1 Satz 2 NHG, §§ 37 Abs. 1 Satz 3 Nr. 5 b), 44 Abs. 1 Satz 3 NHG).

Die Neufassung des Modulverzeichnisses tritt nach deren Bekanntmachung in den Amtlichen Mitteilungen II zum 01.04.2024 in Kraft.

Georg-August-Universität
Göttingen

Modulverzeichnis

zu der Prüfungs- und Studienordnung für den Bachelor-Studiengang "Mathematical Data Science" (Amtliche Mitteilungen I Nr. 21/2018, S. 357, zuletzt geändert durch Amtliche Mitteilungen I Nr. 4/2024 S. 26)

Module

Übersicht nach Modulgruppen

I. Grundlagen Mathematik, Informatik und Data Science

Es müssen Module im Umfang von insgesamt mindestens 87 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

1. Orientierungsmodule

Es müssen folgende zwei Orientierungsmodule im Gesamtumfang von 18 C erfolgreich absolviert werden:

2. Grundlagenmodule Mathematik

Es müssen folgende drei Pflichtmodule im Gesamtumfang von 27 C erfolgreich absolviert werden:

3. Grundlagenmodule Informatik

Es müssen folgende zwei Pflichtmodule im Gesamtumfang von 15 C erfolgreich absolviert werden:

4. Grundlagenmodule Data Science

a.

Es müssen folgende zwei Pflichtmodule im Gesamtumfang von 18 C erfolgreich absolviert werden:

b.

Des Weiteren muss eines der folgenden Wahlpflichtmodule im Umfang von 9 C erfolgreich absolviert werden:

II. Schwerpunktbildung

Im Vertiefungsstudium sind von den in Nr. IV) „Vertiefungsstudium“ genannten Wahlmodulen Module im Umfang von insgesamt mindestens 45 C erfolgreich absolvieren. In einem der dort genannten Fachgebiete ist die Abschlussarbeit anzufertigen, dieses ist zugleich der Studienschwerpunkt.

1. Studienschwerpunkt

In dem Studienschwerpunkt müssen Module im Umfang 24 C erfolgreich absolviert werden.

2. Wissensvertiefung und Wissenverbreiterung

Die verbleibenden 21 C können zur Wissensvertiefung und Wissenverbreiterung frei aus allen vier Fachgebieten gewählt werden.

III. Professionalisierungsbereich

Im Professionalisierungsbereich sind Module im Umfang von insgesamt mindestens 33 C nach Maßgabe der folgenden Bestimmungen erfolgreich zu absolvieren.

1. Programmierkurs

Es muss folgender Programmierkurs im Umfang von 6C absolviert werden:

2. Praktikum Data Science

a.

Von den nachstehenden Modulen muss das Praktikum im Umfang von 9 C erfolgreich absolviert werden, das zu dem Studienschwerpunkt der Abschlussarbeit gehört.

b.

Abweichend davon gelten im Studienschwerpunkt „Maschinelles Lernen“ folgende Regelungen: Es muss wenigstens eines der folgenden Wahlpflichtmodule im Umfang von insgesamt mindestens 9 C erfolgreich absolviert werden:

3. Ethische, gesellschaftliche und rechtliche Grundlagen

Es muss folgendes Pflichtmodul im Umfang von 3 C erfolgreich absolviert werden:

4. Fachbezogene Schlüsselkompetenzen

Es ist mindestens eines der in Nr. V) "Schlüsselkompetenzen" genannten Wahlmodule zu absolvieren, dafür wird folgende Empfehlung gegeben.

5. Fachübergreifende Schlüsselkompetenzen

Ferner können aus dem gesamten universitätsweiten Modulverzeichnis Schlüsselkompetenzen und aus dem Schlüsselkompetenzangebot der Fakultät für Mathematik und Informatik weitere Module frei gewählt werden. Die Belegung anderer Module (Alternativmodule) ist mit Zustimmung der*des Studiendekan*in der Fakultät, die das Modul anbietet, ebenfalls möglich. Die Belegung eines Alternativmoduls ist dem Studienbüro vorab anzuzeigen. Folgende Belegempfehlung wird gegeben.

IV. Vertiefungsstudium

Das Studienangebot des Vertiefungsstudiums im Bachelor-Studiengang „Mathematical Data Science“ setzt sich aus weiterführenden Modulen in den Fächern Mathematik, Informatik und Angewandte Statistik zusammen, die zum Teil in Zyklen organisiert sind. Nachfolgende Module können zugleich für die Zertifizierung des jeweiligen Schwerpunkts verwendet werden.

1. Studienschwerpunkt Optimierung und Bildverarbeitung

In diesem Studienschwerpunkt stehen folgende Wahlmodule zur Auswahl:

2. Studienschwerpunkt Mathematische Statistik

In diesem Studienschwerpunkt stehen folgende Wahlmodule zur Auswahl:

3. Studienschwerpunkt Maschinelles Lernen

In diesem Studienschwerpunkt stehen folgende Wahlmodule zur Auswahl:

4. Studienschwerpunkt Angewandte Statistik und Ökonometrie

In diesem Studienschwerpunkt stehen folgende Wahlmodule zur Auswahl:

V. Schlüsselkompetenzen

Folgende von der Lehreinheit Mathematik oder der Lehreinheit Informatik angebotenen Schlüsselkompetenzmodule können in dem Professionalisierungsbereich eingebracht werden:

VI. Bachelorabschlussmodul

Es muss folgendes Pflichtmodul im Umfang von 15 C erfolgreich absolviert werden:

VII. Methods of examination and glossary

Methods of examination

As far as in this directory of modules a module description is published in the English language the following mapping applies:

Soweit in diesem Modulverzeichnis Modulbeschreibungen in englischer Sprache veröffentlicht werden, gilt für die verwendeten Prüfungsformen nachfolgende Zuordnung:

- Oral examination = mündliche Prüfung [§ 15 Abs. 8 APO]
- Written examination = Klausur [§ 15 Abs. 9 APO]
- Term paper = Hausarbeit [§ 15 Abs. 11 APO]
- Presentation = Präsentation [§ 15 Abs. 12 APO]
- Presentation and written report = Präsentation mit schriftlicher Ausarbeitung [§ 15 Abs. 12 APO]

Glossary

APO = Allgemeinen Prüfungsordnung für Bachelor- und Master-Studiengänge sowie sonstige Studienangebote an der Universität Göttingen

PStO = Prüfungs- und Studienordnung für den Bachelor/Master-Studiengang "Mathematik"

WLH = Weekly lecture hours = SWS

Programme coordinator = Studiengangsbeauftrage/r

Georg-August-Universität Göttingen **Modul B.Inf.1101: Grundlagen der Informatik und Programmierung** *English title: Introduction to Computer Science and Programming*	10 C 6 SWS
Lernziele/Kompetenzen: Studierende • kennen grundlegende Begriffe, Prinzipien und Herangehensweisen der Informatik, kennen einige Programmierparadigmen und Grundzüge der Objektorientierung. • erlangen elementare Grundkenntnisse der Aussagenlogik, verstehen die Bedeutung für Programmsteuerung und Informationsdarstellung und können sie in einfachen Situationen anwenden. • verstehen wesentliche Funktionsprinzipien von Computern und der Informationsdarstellung und deren Konsequenzen für die Programmierung. • erlernen die Grundlagen einer Programmiersprache und können einfache Algorithmen in dieser Sprache codieren. • kennen einfache Datenstrukturen und ihre Eignung in typischen Anwendungssituationen, können diese programmtechnisch implementieren. • analysieren die Korrektheit einfacher Algorithmen und bewerten einfache Algorithmen und Probleme nach ihrem Ressourcenbedarf.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 216 Stunden
Lehrveranstaltung: Informatik I (Vorlesung, Übung)	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Nachweis von 50% der in den Übungsaufgaben erreichbaren Punkte. Kontinuierliche Teilnahme an den Übungen. **Prüfungsanforderungen:** In der Prüfung wird das Verständnis der vermittelten Grundbegriffe sowie die aktive Beherrschung der vermittelten Inhalte und Techniken nachgewiesen, z.B. • Kenntnis von Grundbegriffen nachweisen durch Umschreibung in eigenen Worten. • Standards der Informationsdarstellung in konkreter Situation umsetzen. • Ausdrücke auswerten oder Bedingungen als logische Ausdrücke formulieren usw. • Programmablauf auf gegebenen Daten geeignet darstellen. • Programmcode auch in nicht offensichtlichen Situationen verstehen. • Fehler im Programmcode erkennen/korrigieren/klassifizieren. • Datenstrukturen für einfache Anwendungssituationen auswählen bzw. geeignet in einem Kontext verwenden. • Algorithmen für einfache Probleme auswählen und beschreiben (ggf. nach Hinweisen) und/oder einen vorgegebenen Algorithmus (ggf. fragmentarisch) programmieren bzw. ergänzen. • einfache Algorithmen/Programme nach Ressourcenbedarf analysieren. • einfachsten Programmcode auf Korrektheit analysieren. • einfache Anwendungssituation geeignet durch Modul- oder Klassenschnittstellen modellieren. Die Klausur wird als **E-Prüfung** durchgeführt.	10 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Carsten Damm
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** ab bis
Maximale Studierendenzahl: 300	

Georg-August-Universität Göttingen **Modul B.Inf.1102: Grundlagen der Praktischen Informatik** *English title: Introduction to Computer Systems*	10 C 6 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Die Studierenden • beherrschen die Grundlagen einer deklarativen Programmiersprache und können Programme erstellen, testen und analysieren. • beherschen die Grundlagen einer Programmiersprache, die als Skriptsprache nutzbar ist, und können Skripte erstellen, testen und analysieren. • kennen Aufgaben und Struktur eines Betriebssystems, die Verfahren zur Verwaltung, Scheduling und Synchronisation von Prozessen und zur Speicherverwaltung, sie können diese Verfahren jeweils anwenden, analysieren und vergleichen. • kennen Grundlagen und verschiedene Beschreibungen von formalen Sprachen, z.B. Automaten und Grammatiken, und können diese konstruieren, analysieren und vergleichen. • kennen Grundlagen des Compilerbaus und können einfache Versionen der zugehörigen Softwarewerkzeuge, z.B. Lexer, Parser, Interpeter und Compiler, konstruieren und analysieren. • kennen verschiedene Teilgebieten der formalen Logik, z.B. Aussagen- und Prädikatenlogik, und darauf beruhende Verfahren, z.B. Auswertung, Konstruktion und Resolution, und können diese anwenden. • kennen die Schichtenarchitektur von Computernetzwerken, sowie sowohl Dienste als auch Protokolle und können diese analysieren und vergleichen. • kennen unterschiedliche Verschlüsselungsverfahren, z.B. symmetrische und asymmetrische, sowie Methoden sowohl zum Schlüsselaustausch als auch zur Schlüsselvereinbarung und können diese anwenden, analysieren und vergleichen. • kennen die Grundlagen einzelnen Teilgebiete der Softwaretechnik, z.B. Softwaretest, und können diese anwenden und analysieren.	Präsenzzeit: 84 Stunden Selbststudium: 216 Stunden

Lehrveranstaltung: Grundlagen der Praktischen Informatik (Vorlesung, Übung)	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Nachweis von 50% der in den Übungsaufgaben erreichbaren Punkte. Kontinuierliche Teilnahme an den Übungen. **Prüfungsanforderungen:** Deklarative Programmierung, Programmierung von Skripten, Betriebssysteme, formale Sprachen, Compilerbau, formale Logik, Telematik, Kryptographie, Softwaretechnik Die Klausur wird als **E-Prüfung** durchgeführt.	10 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Inf.1101
Sprache:	**Modulverantwortliche[r]:**

Deutsch	Dr. Henrik Brosenne
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 300	

Georg-August-Universität Göttingen **Modul B.Inf.1103: Algorithmen und Datenstrukturen** *English title: Algorithms and Data Structures*	10 C 6 SWS
Lernziele/Kompetenzen: Erwerb grundlegender Fähigkeiten im Umgang mit den Konzepten der theoretischen Informatik, insbesondere mit dem Verhältnis von Determinismus zu Nichtdeterminismus; Analyse und Entwurfsmethoden für effiziente Algorithmen zu wichtigen Problemstellungen.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 216 Stunden
Lehrveranstaltung: Algorithmen und Datenstrukturen (Vorlesung, Übung)	6 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** Nachweis von 50% der in den Übungsaufgaben erreichbaren Punkte. Kontinuierliche Teilnahme an den Übungen. **Prüfungsanforderungen:** Effiziente Algorithmen für grundlegende Probleme (z.B. Suchen, Sortieren, Graphalgorithmen), Rekursive Algorithmen, Greedy-Algorithmen, Branch and Bound, Dynamische Programmierung, NP-Vollständigkeit	10 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Inf.1101
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Florin-Silviu Manea
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 200	

Georg-August-Universität Göttingen **Modul B.Inf.1201: Theoretische Informatik** *English title: Theoretical Computer Science*	5 C 3 SWS

Lernziele/Kompetenzen: Studierende • kennen grundlegende Begriffe und Methoden der theoretischen Informatik im Bereich formale Sprachen, Automaten und Berechenbarkeit. • verstehen Zusammenhänge zwischen diesen Gebieten und sowie Querbezüge zur praktischen Informatik. • wenden die klassischen Sätze, Aussagen und Methoden der theoretischen Informatik in typischen Beispielen an. • klassifizieren formale Sprachen nach Chomsky-Typen. • bewerten Probleme hinsichtlich ihrer (Semi-)Entscheidbarkeit.	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 108 Stunden

Lehrveranstaltung: Theoretische Informatik (Vorlesung, Übung)	3 SWS
Prüfung: Klausur (90 Minuten) oder mündliche Prüfung (ca. 20 Min.) **Prüfungsvorleistungen:** Bearbeitung von 50% aller Übungsblätter, Vorführung mindestens einer Aufgabe während der Übung, kontinuierliche Teilnahme an den Übungen. **Prüfungsanforderungen:** In der Prüfung wird neben dem theoretischen Verständnis zentraler Begriffe der theoretischen Informatik die aktive Beherrschung der vermittelten Inhalte und Techniken nachgewiesen, z.B. • durch Grammatik oder Akzeptormodell gegebene formale Sprache der nachweisbar richtigen Hierarchiestufe zuordnen, für gegebenes Wortproblem einen möglichst effizienten Entscheidungsalgorithmus konstruieren, dessen Laufzeitverhalten analysieren. • aus Grammatik entsprechenden Akzeptor konstruieren (oder umgekehrt), Grammatik in Normalform überführen, reguläre Ausdrücke in endlichen Automaten überführen, Typ3-Grammatik in regulären Ausdruck usw. • Algorithmus in vorgegebener Formalisierung darstellen, einfache Nichtentscheidbarkeitsbeweise durch Reduktion führen oder Abschlusseigenschaften von Sprachklassen herleiten, Semi-Entscheidbarkeit konkreter Probleme nachweisen.	5 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundlagen der Informatik, der Programmierung und der diskreten Mathematik.
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Carsten Damm
Angebotshäufigkeit: jährlich	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Inf.1202: Formale Systeme** *English title: Formal Systems*	5 C 3 SWS

Lernziele/Kompetenzen: Die Studierenden • können Sachverhalte in geeigneten logischen Systemen formalisieren und mit diesen Formalisierungen umgehen. • verstehen grundlegende Begriffe und Methoden der mathematischen Logik. • können die Ausdrucksstärke und Grenzen logischer Systeme beurteilen. • beherrschen elementare Darstellungs- und Modellierungstechniken der Informatik, kennen die zugehörigen fundamentalen Algorithmen und können diese anwenden und analysieren.	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 108 Stunden

Lehrveranstaltung: Formale Systeme (Vorlesung, Übung)	
Prüfung: Klausur (90 Minuten) oder mündliche Prüfung (ca. 20 Min.) **Prüfungsvorleistungen:** Aktive Teilnahme an den Übungen, belegt durch Nachweis von 50% der in den Übungsaufgaben eines Semesters erreichbaren Punkte. **Prüfungsanforderungen:** • Strukturen, Syntax und Semantik von Aussagen- und Prädikatenlogik. • Einführung in weitere Logiken (z.B. Logiken höherer Stufe). • Entscheidbarkeit, Unentscheidbarkeit und Komplexität von logischen Spezifikationen. • Grundlagen zu algebraischen Strukturen und partiell geordneten Mengen. • Syntaxdefinitionen durch Regelsysteme und ihre Anwendung. • Transformation und Analyseverfahren für Regelsysteme. • Einfache Modelle der Nebenläufigkeit (z.B. Petrinetze).	5 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Inf.1101
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Winfried Kurth
Angebotshäufigkeit: jährlich	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Inf.1206: Datenbanken** *English title: Databases*	5 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden kennen die theoretischen Grundlagen sowie technischen Konzepte von Datenbanksystemen. Mit den erworbenen Kenntnissen in konzeptueller Modellierung und praktischen Grundkenntnissen in der am weitesten verbreiteten Anfragesprache "SQL" können sie einfache Datenbankprojekte durchführen. Sie wissen, welche grundlegende Funktionalität ihnen ein Datenbanksystem dabei bietet und können diese nutzen. Sie können sich ggf. auf der Basis dieser Kenntnisse mit Hilfe der üblichen Dokumentation in diesem Bereich selbständig weitergehend einarbeiten. Die Studierenden verstehen den Nutzen eines fundierten mathematisch-theoretischen Hintergrundes auch im Bereich praktischer Informatik.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 94 Stunden

Lehrveranstaltung: Datenbanken (Vorlesung, Übung) *Inhalte*: Konzeptuelle Modellierung (ER-Modell), relationales Modell, relationale Algebra (als theoretische Grundlage der Anfragekonzepte), SQL-Anfragen, -Updates und Schemaerzeugung, Transaktionen, Normalisierungstheorie. Literatur: R. Elmasri, S.B. Navathe: Grundlagen von Datenbanksystemen - Ausgabe Grundstudium (dt. Übers.), Pearson Studium (nach Praxisrelevanz ausgewählte Themen).	4 SWS
Prüfung: Klausur (120 Min.) oder mündliche Prüfung (ca. 20 Min.)	5 C

Prüfungsanforderungen: Nachweis über aufgebaute weiterführende Kompetenzen in den folgenden Bereichen: theoretische Grundlagen sowie technische Konzepte von Datenbanksystemen, konzeptuelle Modellierung und praktische Grundkenntnisse in der am weitesten verbreiteten Anfragesprache "SQL" in ihrer Anwendung auf einfache Datenbankprojekte, Nutzung grundlegender Funktionalitäten von Datenbanksystem, mathematisch-theoretischer Hintergründe in der praktischen Informatik. Fähigkeit, die vorstehenden Kompetenzen weiter zu vertiefen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Inf.1101
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Wolfgang May
Angebotshäufigkeit: jährlich	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen Module B.Inf.1231: Infrastructures of Data Science	6 C 4 WLH
Learning outcome, core skills: Upon completion the course, students • understand the basic functions of data science infrastructures and their significance. • understand basic data types and their specifics. • understand the most important technical infrastructures for storing and processing data locally and in the cloud as well as their advantages and disadvantages in relation to data science applications. • can apply the concept of the data lake to basic data science problems. • are able to apply the different steps of data pre-processing to selected data sets. • can identify the characteristics of time series and graph data and are able to recall the functions of DBMSs designed for their processing. • can present the basic tasks of data analysis platforms and can describe them using examples. • can apply methods and tools for the presentation and visualisation of data. • can model basic data science workflows and are able to transfer their knowledge to basic data science projects.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Infrastructures of Data Science (Lecture, Exercise) *Contents*: • Data types and their characteristics • Common functions of data science infrastructures • Storage, compute, and cloud infrastructures for data science • Concept of a data lake • Data pre-processing methods and selected tools • Time series and graph data, the respective DBMS, and query languages • Data analytics platforms • Data presentation and visualization • Data science workflows and selected infrastructure components	4 WLH
Examination: In-class, written exam (90 min) or oral exam (approx. 30 min.) **Examination prerequisites:** Students complete 50% of the homework exercises. **Examination requirements:** Through the examination students demonstrate that they are able to describe basic functions of (cloud-based) data science infrastructures as well as to specify and identify basic data types. Students can also prove their understanding of data lakes and can apply their knowledge of MapReduce and Hadoop in that particular context. They can analyse basic data pre-processing problems and sketch common solutions. Student can show that they understand time series and graph data as well as the corresponding DBMS and that they can present common tasks of data analysis platforms. Through the examination, students also demonstrate their ability to select appropriate methods for visualising data and show that they are able to create basic data science workflows.	6 C

Admission requirements: none	**Recommended previous knowledge:** Python and basic database knowledge (recommended, not mandatory)
Language: English	**Person responsible for module:** Hon.-Prof. Dr. Philipp Wieder
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 3 - 6; Master: 1 - 2
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module B.Inf.1236: Machine Learning**	6 C 4 WLH
Learning outcome, core skills: Students • learn concepts and techniques of machine learning and understand their advantages and disadvantages compared with alternative approaches • learn techniques of supervised learning for classification and regression • learn techniques of unsupervised learning for density estimation, dimensionality reduction and clustering • implement machine learning algorithms like linear regression, logistic regression, kernel methods, tree-based methods, neural networks, principal component analysis, k-means and Gaussian mixture models • solve practical data science problems using machine learning methods	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Machine Learning (Lecture) Bishop: Pattern recognition and machine learning. https://cs.ugoe.de/prml	2 WLH
Examination: Written examination (90 minutes) **Examination prerequisites:** B.Inf.1236.Ex: At least 50% of homework exercises solved and N-1 attempts presented to tutors **Examination requirements:** Knowledge of the working principles, advantages and disadvantages of the machine learning methods covered in the lecture	6 C
Course: Machine Learning - Exercise (Exercise) *Contents*: Students present their solutions of the homework exercises to tutors and discuss them with their tutors.	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Knowledge of basic linear algebra and probability English language proficiency at level B2 (CEFR)
Language: English	**Person responsible for module:** Prof. Dr. Alexander Ecker
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 4
Maximum number of students: 100	

Georg-August-Universität Göttingen **Module B.Inf.1237: Deep Learning for Computer Vision**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Students • learn concepts and techniques of deep learning and understand their advantages and disadvantages compared to alternative approaches • learn to solve practical data science problems using deep learning • implement deep learning techniques like multi-layer perceptrons, convolutional neural networks and other modern deep learning architectures • learn techniques for optimization and regularization of deep neural networks • learn applications of deep neural networks for computer vision tasks such as segmentation and object detection	Attendance time: 56 h Self-study time: 124 h

Course: Deep Learning for Computer Vision (Lecture)	2 WLH
Goodfellow, Bengio, Courville: Deep Learning. https://www.deeplearningbook.org Bishop: Pattern Recognition and Machine Learning. https://cs.ugoe.de/prml	
Examination: Written examination (90 minutes) **Examination prerequisites:** B.Inf.1237.Ex: At least 50% of homework exercises solved and N-1 attempts presented to tutors **Examination requirements:** Knowledge of basic deep learning techniques, their advantages and disadvantages and approaches to optimization and regularization. Ability to implement these techniques.	6 C

Course: Deep Learning for Computer Vision - Exercise (Exercise)	2 WLH
Contents: Students present their solutions of the homework exercises to tutors and discuss them with their tutors.	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of linear algebra and probability Completion of B.Inf.1236 Machine Learning or equivalent
Language: English	**Person responsible for module:** Prof. Dr. Constantin Pape Prof. Dr. Alexander Ecker
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 5
Maximum number of students: 100	

Georg-August-Universität Göttingen **Module B.Inf.1240: Visualization**	6 C 4 WLH

Learning outcome, core skills: Knowledge of • the potentials and limitations of data visualization • the fundamentals of visual perception and cognition and their implications for data visualization. Students can apply these to the design of visualizations and detect manipulative design choices • a broad variety of techniques for visual representation of data, including abstract and high-dimensional data. Students can select appropriate methods on new problems • integration of visualization into the data analysis process, algorithmic generation and interactive methods	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Visualization (Lecture, Exercise)	4 WLH
Examination: Practical project (2-3 weeks) with presentation and questions during oral exam in groups (approx. 20 minutes per examinee). **Examination prerequisites:** At least 50% of homework exercises solved. **Examination requirements:** Knowledge of potentials and limitations of data visualization, fundamentals of visual perception and their implications for good design choices, techniques for visual representation and how to use them.	6 C

Admission requirements: none	**Recommended previous knowledge:** Foundations of linear algebra and analysis (e.g. B.Mat.0801 and B.Mat.0802) and programming skills (e.g. B.Inf.1842).
Language: English	**Person responsible for module:** Prof. Dr. Bernhard Schmitzer
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 6
Maximum number of students: 50	

Georg-August-Universität Göttingen Module B.Inf.1241: Computational Optimal Transport	6 C 4 WLH
Learning outcome, core skills: Knowledge of • the fundamental notions of optimal transport, and its strengths and limitations as a data analysis tool • the discrete Kantorovich formulation, its convex duality, and Wasserstein distances • classical numerical algorithms, entropic regularization, and their scopes of applicability • examples for data analysis applications. Students can transfer these to new potential applications	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Computational Optimal Transport (Lecture, Exercise)	4 WLH
Examination: Written exam (90 minutes) or oral exam (approx. 20 minutes) **Examination prerequisites:** At least 50% of homework exercises solved. **Examination requirements:** Knowledge of Kantorovich duality, Wasserstein distances, standard algorithms and implications for data analysis applications.	6 C

Admission requirements: none	**Recommended previous knowledge:** Foundations of linear algebra and analysis (e.g. B.Mat.0801 and B.Mat.0802) and programming skills (e.g. B.Inf.1842).
Language: English	**Person responsible for module:** Prof. Dr. Bernhard Schmitzer
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 4 - 6
Maximum number of students: 50	

Georg-August-Universität Göttingen **Modul B.Inf.1504: Maschinelles Lernen in der Bioinformatik** *English title: Maschine Learning in Bioinformatics*	6 C 4 SWS
Lernziele/Kompetenzen: Es sollen grundlegende Konzepte das maschinellen Lernens anschaulich vermittelt werden. Ziel ist das Verständnis der statistischen Voraussetzungen und der algorithmischen Umsetzung von maschinellen Lernverfahren. Dabei soll sowohl eine formale Beschreibung als auch die Implementation von einzelnen Methoden praktisch nachvollzogen werden können. Die Anwendungsmöglichkeiten der Methoden sollen vornehmlich im Kontext von mehrdimensionalen biomedizinschen Daten diskutiert und erprobt werden.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Maschinelles Lernen (Vorlesung, Übung)	4 SWS
Prüfung: Mündlich (ca. 20 Minuten)	6 C
Prüfungsanforderungen: Die Studierenden können Konzepte des Maschinellen Lernens selbständig verstehen und anwenden.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Biologische und mathematische Grundkenntnisse
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Peter Meinicke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 5
Maximale Studierendenzahl: 15	

Georg-August-Universität Göttingen **Modul B.Inf.1701: Vertiefung theoretischer Konzepte der Informatik** *English title: Advanced Theoretical Computer Science*	5 C 3 SWS
Lernziele/Kompetenzen: Dieses Modul baut die Kompetenzen aus dem Modul B.Inf.1201 aus. Es geht um den Erwerb fortgeschrittener Kompetenz im Umgang mit theoretischen Konzepten der Informatik und den damit verbundenen mathematischen Techniken und Modellierungstechniken.	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 108 Stunden
Lehrveranstaltung: Vorlesungen zur Codierungstheorie, Informationstheorie oder Komplexitätstheorie (Vorlesung, Übung) *Inhalte*: Vertiefung in einem der folgenden Gebiete: Komplexitätstheorie (Erkundung der Grenzen effizienter Algorithmen), Datenstrukturen für boolesche Funktionen, Kryptographie, Informationstheorie, Codierungstheorie, Signalverarbeitung.	
Prüfung: Klausur (90 Minuten) oder mündliche Prüfung (ca. 20 Min.)	5 C
Prüfungsanforderungen: Nachweis über den Erwerb vertiefter weiterführender Kompetenzen aus dem Kompetenzbereich der Module *B.Inf.1201 Theoretische Informatik* oder *B.Inf.1202 Formale Systeme*.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Inf.1201, B.Inf.1202
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Carsten Damm
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Inf.1831: Ethische, gesellschaftliche und rechtliche Grundlagen für Data Science** *English title: Ethical, Social, and Legal Foundations of Data Science*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichen Abschluss des Modules können Studenten: • die grundlegenden Konzepte der Ethik in Data Science sowie die rechtliche Grundlage in Deutschland und Europa definieren, • Prozesse und Werkzeuge für die Analyse von ethischen und rechtliche Fragestellungen benennen und anwenden, • mögliche Konsequenzen der Sammlung, Verarbeitung, Speicherung, Verwaltung und Freigabe von Daten erkennen und die resultierenden Risiken ableiten, • geeignete technische Methoden und Lösungen benennen und auswählen, um die Risiken zu minimieren.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Ethische, gesellschaftliche und rechtliche Grundlagen für Data Science (Vorlesung)	2 SWS
Prüfung: Hausarbeit (max. 4 Seiten), unbenotet **Prüfungsanforderungen:** Angewandte Ethik, ethische und rechtliche Rahmenwerke, Datenschutz und Privatheit, Anonymität, Dateneigentümerschaft, Nutzereinverständnis, Datensammlung, Datenverarbeitung, Datenspeicherung, Datenverwaltung, Datenfreigabe, Überwachung.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Delphine Reinhardt
Angebotshäufigkeit: jährlich	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Inf.1833: Fachpraktikum Data Science** *English title: Training Data Science*	9 C 6 SWS

Lernziele/Kompetenzen: Das Praktikum ist in einem speziellen Fachgebiet der Data Science (siehe Wahlmodule „Data Science“) angesiedelt. Die Lernziele und Kompetenzen ergeben sich aus den dort dargestellten.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Fachpraktikum Data Science (Praktikum)	6 SWS
Prüfung: Vortrag (ca. 15 Min.) mit schriftlicher Ausarbeitung (max. 15 Seiten), unbenotet **Prüfungsvorleistungen:** Bearbeitung von praktischen Aufgaben. **Prüfungsanforderungen:** Nachweis über den Erwerb der folgenden Kenntnisse und Fähigkeiten: Die in den Modulen B.Inf.1131, B.WIWI-QMW.0011, B.Inf.1841 und B.Inf.1842 erworbenen Kompetenzen und Fähigkeiten werden fachspezifisch vertieft.	9 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Inf.1131, B.Inf.1841, B.Inf.1842, B.WIWI-QMW.0011
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Alexander Ecker
Angebotshäufigkeit: jährlich	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul B.Inf.1834: Fachpraktikum Data Science I (klein)** *English title: Training Data Science I*	5 C 3 SWS
Lernziele/Kompetenzen: Das Praktikum ist im Bereich „Infrastruktur und Prozesse“ oder „Datenanalyse“ angesiedelt (siehe Fachgruppen 2.a.II & 2.a.III). Die in den genannten Themengebieten erworbenen Kenntnisse werden erweitert und praktisch angewendet.	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 108 Stunden
Lehrveranstaltung: Fachpraktikum Data Science I (klein) (Praktikum)	3 SWS
Prüfung: Mündlich (ca. 15 Minuten), unbenotet **Prüfungsvorleistungen:** Erfolgreiche Bearbeitung von praktischen Aufgaben. **Prüfungsanforderungen:** Nachweis über den Erwerb der folgenden Kenntnisse und Fähigkeiten: Die in einem Module aus dem Professionalisierungsbereich Data Science erworbenen Kompetenzen und Fähigkeiten werden, mit den als Schlüsselkompetenzen erworbenen Programmierkenntnissen, fachspezifisch vertieft.	5 C

Zugangsvoraussetzungen: Die zugehörige Fachvorlesung; imperative und objektorientierte Programmierung; Programmierwerkzeuge; Verwendung von Application Programming Interfaces; Dokumentation von Softwaresystemen; Softwaretests; Prinzipien und Methoden der projektbasierten Teamarbeit.	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Fabian Sinz
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Bemerkungen:
Das in Modul B.Inf.1834 eingebrachte Praktikum darf nicht dasselbe sein wie in Modul B.Inf.1835.

Georg-August-Universität Göttingen **Modul B.Inf.1835: Fachpraktikum Data Science II (klein)** *English title: Training Data Science II*	5 C 3 SWS

Lernziele/Kompetenzen: Das Praktikum ist im Bereich „Infrastruktur und Prozesse" oder „Datenanalyse" angesiedelt (siehe Fachgruppen 2.a.II & 2.a.III). Die in den genannten Themengebieten erworbenen Kenntnisse werden erweitert und praktisch angewendet.	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 108 Stunden

Lehrveranstaltung: Fachpraktikum Data Science II (klein) (Praktikum)	3 SWS
Prüfung: Mündlich (ca. 15 Minuten), unbenotet **Prüfungsvorleistungen:** Erfolgreiche Bearbeitung von praktischen Aufgaben. **Prüfungsanforderungen:** Nachweis über den Erwerb der folgenden Kenntnisse und Fähigkeiten: Die in einem Module aus dem Professionalisierungsbereich Data Science erworbenen Kompetenzen und Fähigkeiten werden, mit den als Schlüsselkompetenzen erworbenen Programmierkenntnissen, fachspezifisch vertieft.	5 C

Zugangsvoraussetzungen: Die zugehörige Fachvorlesung; imperative und objektorientierte Programmierung; Programmierwerkzeuge; Verwendung von Application Programming Interfaces; Dokumentation von Softwaresystemen; Softwaretests; Prinzipien und Methoden der projektbasierten Teamarbeit.	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Fabian Sinz
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Bemerkungen: Das in Modul B.Inf.1835 eingebrachte Praktikum darf nicht dasselbe sein wie in Modul B.Inf.1834.

Georg-August-Universität Göttingen **Modul B.Inf.1841: Programmieren für Data Scientists I** *English title: Programming for Data Scientists I*	5 C 3 SWS
Lernziele/Kompetenzen: Die Studierenden erlernen eine aktuelle Programmiersprache, sie • beherrschen den Einsatz von Editor, Compiler und weiteren Programmierwerkzeugen (z.B. Build-Management-Tools). • kennen grundlegende Techniken des Programmentwurfs und können diese anwenden. • kennen Standarddatentypen (z.B. für ganze Zahlen und Zeichen) und spezielle Datentypen (z.B. Felder und Strukturen). • kennen die Operatoren der Sprache und können damit gültige Ausdrücke bilden und verwenden. • kennen die Anweisungen zur Steuerung des Programmablaufs (z.B. Verzweigungen und Schleifen) und können diese anwenden. • kennen die Möglichkeiten zur Strukturierung von Programmen (z.B. Funktionen und Module) und können diese einsetzen. • kennen die Techniken zur Speicherverwaltung und können diese verwenden. • kennen die Möglichkeiten und Grenzen der Rechnerarithmetik (z.B. Ganzzahl- und Gleitkommarithmetik) und können diese beim Programmentwurf berücksichtigen. • kennen die Programmbibliotheken und können diese einsetzen.	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 108 Stunden
Lehrveranstaltung: Grundlagen der C-Programmierung (Vorlesung, Übung)	3 SWS
Prüfung: Klausur (90 Minuten), unbenotet **Prüfungsanforderungen:** Standarddatentypen, Konstanten, Variablen, Operatoren, Ausdrücke, Anweisungen, Kontrollstrukturen zur Steuerung des Programmablaufs, Strings, Felder, Strukturen, Zeiger, Funktionen, Speicherverwaltung, Rechnerarithmetik, Ein-/Ausgabe, Module, Standardbibliothek, Präprozessor, Compiler, Linker	5 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Henrik Brosenne
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul B.Mat.0011: Analysis I** *English title: Analysis I*	9 C 6 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit analytischem mathematischem Grundwissen vertraut. Sie • wenden ihr Wissen über Mengen und Logik in verschiedenen Beweistechniken an; • gehen sicher mit Ungleichungen reeller Zahlen sowie mit Folgen und Reihen reeller und komplexer Zahlen um; • untersuchen reelle und komplexe Funktionen in einer Veränderlichen auf Stetigkeit, Differenzierbarkeit und Integrierbarkeit; • berechnen Integrale und Ableitungen von reellen und komplexen Funktionen in einer Veränderlichen. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Kompetenzen im Bereich der Analysis erworben. Sie • formulieren mathematische Sachverhalte aus analytischen Bereichen in schriftlicher und mündlicher Form korrekt; • lösen Probleme anhand von Fragestellungen der reellen, eindimensionalen Analysis; • analysieren klassische Funktionen und ihre Eigenschaften mit Hilfe von funktionalem Denken; • erfassen grundlegende Eigenschaften von Zahlenfolgen und Funktionen; • sind mit der Entwicklung eines mathematischen Gebietes aus einem Axiomensystem vertraut.	Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Differenzial- und Integralrechnung I	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.0011.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorstellen von Lösungen in den Übungen	9 C

Lehrveranstaltung: Differenzial- und Integralrechnung I - Übung	2 SWS

Lehrveranstaltung: Differenzial- und Integralrechnung I - Praktikum Das Praktikum ist ein optionales Angebot zum Training des Problemlösens.	

Prüfungsanforderungen: Grundkenntnisse der Analysis, Verständnis des Grenzwertbegriffs, Beherrschen von Beweistechniken	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine

Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Bemerkung	**Empfohlenes Fachsemester:** 1 - 3
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts
- Pflichtmodul in den Bachelor-Studiengängen Mathematik und Physik sowie im Zwei-Fächer-Bachelorstudiengang mit Fach Mathematik
- Im Bachelor-Studiengang Angewandte Informatik kann dieses Modul zusammen mit B.Mat.0012 die Module B.Mat.0801 und B.Mat.0802 ersetzen.
- Universitätsweites Schlüsselkompetenzangebot; als solches nicht verwendbar für Studierende im Zwei-Fächer-Bachelor Studiengang mit Fach Mathematik, Studiengang Master of Education mit Fach Mathematik, Bachelor/Master-Studiengang Mathematik und Promotionsstudiengang Mathematical Sciences.

Wiederholungsregelungen

- Nicht bestandene Prüfungen zu diesem Modul können dreimal wiederholt werden.
- Ein vor Beginn der Vorlesungszeit des ersten Fachsemesters, z.B. im Rahmen des mathematischen Sommerstudiums, absolvierter Prüfungsversuch im Modul B.Mat.0011 "Analysis I" gilt im Falle des Nichtbestehens als nicht unternommen (Freiversuch); eine im Freiversuch bestandene Modulprüfung kann einmal zur Notenverbesserung wiederholt werden; durch die Wiederholung kann keine Verschlechterung der Note eintreten. Eine Wiederholung von bestandenen Prüfungen zum Zwecke der Notenverbesserung ist im Übrigen nicht möglich; die Bestimmung des §16 a Abs. 3 Satz 2 APO bleibt unberührt.

Georg-August-Universität Göttingen **Modul B.Mat.0012: Analytische Geometrie und Lineare Algebra I** *English title: Analytic geometry and linear algebra I*	9 C 6 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit mathematischem Grundwissen vertraut. Sie • definieren Vektorräume und lineare Abbildungen; • beschreiben lineare Abbildungen durch Matrizen; • lösen lineare Gleichungssysteme und Eigenwertprobleme und berechnen Determinanten; • erkennen Vektorräume mit geometrischer Struktur und ihre strukturerhaltenden Homomorphismen, insbesondere im Fall euklidischer Vektorräume. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Kompetenzen in den Bereichen der analytischen Geometrie und der linearen Algebra erworben. Sie • formulieren mathematische Sachverhalte aus dem Bereich der linearen Algebra in schriftlicher und mündlicher Form korrekt; • lösen Probleme anhand von Fragestellungen der linearen Algebra; • erfassen das Konzept der Linearität bei unterschiedlichen mathematischen Objekten; • nutzen lineare Strukturen, insbesondere den Isomorphiebegriff, für die Formulierung mathematischer Beziehungen; • erfassen grundlegende strukturelle Eigenschaften linearer und euklidischer Vektorräume; • sind mit der Entwicklung eines mathematischen Gebietes aus einem Axiomensystem vertraut.	Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Analytische Geometrie und Lineare Algebra I	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.0012.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorstellen von Lösungen in den Übungen	9 C

Lehrveranstaltung: Analytische Geometrie und Lineare Algebra I - Übung	2 SWS

Lehrveranstaltung: Analytische Geometrie und Lineare Algebra I - Praktikum Das Praktikum ist ein optionales Angebot zum Training des Problemlösens.	

Prüfungsanforderungen: Grundkenntnisse der linearen Algebra, insbesondere über Lösbarkeit und Lösungen linearer Gleichungssysteme	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 1 - 3
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts
- Pflichtmodul in den Bachelor-Studiengängen Mathematik und Physik sowie im Zwei-Fächer-Bachelorstudiengang mit Fach Mathematk
- Im Bachelor-Studiengang Angewandte Informatik kann dieses Modul zusammen mit B.Mat.0011 die Module B.Mat.0801 und B.Mat.0802 ersetzen.
- Universitätsweites Schlüsselkompetenzangebot; als solches nicht verwendbar für Studierende im Zwei-Fächer-Bachelor Studiengang mit Fach Mathematik, Studiengang Master of Education mit Fach Mathematik, Bachelor/Master-Studiengang Mathematik und Promotionsstudiengang Mathematical Sciences.

Georg-August-Universität Göttingen **Modul B.Mat.0021: Analysis II** *English title: Analysis II*	9 C 6 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit weitreichendem analytischen mathematischen Grundwissen vertraut. Sie • beschreiben topologische Grundbegriffe mathematisch korrekt; • untersuchen Funktionen in mehreren Veränderlichen auf Stetigkeit, Differenzierbarkeit und Integrierbarkeit; • berechnen Integrale und Ableitungen von Funktionen in mehreren Veränderlichen; • nutzen Konzepte der Maß- und Integrationstheorie zur Berechnung von Integralen; • benennen Aussagen zur Existenz und Eindeutigkeit von Lösungen gewöhnlicher Differenzialgleichungen. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Kompetenzen im Bereich der Analysis erworben. Sie • formulieren mathematische Sachverhalte aus analytischen Bereichen in schriftlicher und mündlicher Form korrekt; • lösen Probleme anhand von Fragestellungen der reellen, mehrdimensionalen Analysis; • analysieren klassische Funktionen in mehreren Variablen und ihre Eigenschaften mit Hilfe von funktionalem Denkens; • erfassen grundlegende topologische Eigenschaften; • sind mit der Entwicklung eines mathematischen Gebietes aus einem Axiomensystem vertraut.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden
Lehrveranstaltung: Differenzial- und Integralrechnung II	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.0021.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorstellen von Lösungen in den Übungen	9 C
Lehrveranstaltung: Differenzial- und Integralrechnung II - Übung	2 SWS
Lehrveranstaltung: Differenzial- und Integralrechnung II - Praktikum Das Praktikum ist ein optionales Angebot zum Training des Problemlösens.	
Prüfungsanforderungen: Grundkenntnisse der Differenzial- und Integralrechnung in mehreren Veränderlichen sowie der Maß- und Integrationstheorie, Fähigkeit des Problemlösens	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0011, B.Mat.0012

Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 2 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts
- Im Zwei-Fächer-Bachelorstudiengang, Fach Mathematik, kann dieses Modul das Modul B.Mat.0025 "Methoden der Analysis II" ersetzen.
- Universitätsweites Schlüsselkompetenzangebot; als solches nicht verwendbar für Studierende im Zwei-Fächer-Bachelor Studiengang mit Fach Mathematik, Studiengang Master of Education mit Fach Mathematik, Bachelor/Master-Studiengang Mathematik und Promotionsstudiengang Mathematical Sciences.

Georg-August-Universität Göttingen **Modul B.Mat.0022: Analytische Geometrie und Lineare Algebra II** *English title: Analytic geometry and linear algebra II*	9 C 6 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit mathematischem Grundwissen vertraut. Sie • bestimmen Normalformen von Matrizen; • erkennen Bilinearformen und Kegelschnitte; • sind mit den Konzepten der affinen und projektiven Geometrie vertraut; • erkennen Strukturen bei Gruppen, Ringen und Moduln. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Kompetenzen in Bereichen der analytischen Geometrie und der linearen Algebra erworben. Sie • formulieren mathematische Sachverhalte aus dem Bereich der Geometrie in schriftlicher und mündlicher Form korrekt; • lösen Probleme anhand von Fragestellungen der analytischen Geometrie; • wenden Konzepte der linearen Algebra auf geometrische Fragestellungen an; • erfassen grundlegende strukturelle Eigenschaften linearer und euklidischer Vektorräume; • sind mit der Entwicklung eines mathematischen Gebietes aus einem Axiomensystem vertraut.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Analytische Geometrie und Lineare Algebra II	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.0022.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Lehrveranstaltung: Analytische Geometrie und Lineare Algebra II - Übung	2 SWS

Lehrveranstaltung: Analytische Geometrie und Lineare Algebra II - Praktikum Das Praktikum ist ein optionales Angebot zum Training des Problemlösens.	

Prüfungsanforderungen: Grundkenntnisse geometrischer Begriffe und in linearer Algebra	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0011, B.Mat.0012
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit:	**Dauer:**

jedes Sommersemester	1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 2 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts
- Im Zwei-Fächer-Bachelorstudiengang, Fach Mathematik, kann dieses Modul das Modul B.Mat.0026 "Geometrie" ersetzen.
- Universitätsweites Schlüsselkompetenzangebot; als solches nicht verwendbar für Studierende im Zwei-Fächer-Bachelor Studiengang mit Fach Mathematik, Studiengang Master of Education mit Fach Mathematik, Bachelor/Master-Studiengang Mathematik und Promotionsstudiengang Mathematical Sciences.

Georg-August-Universität Göttingen **Modul B.Mat.0721: Mathematisch orientiertes Programmieren** *English title: Mathematics related programming*	6 C 3 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele: Das erfolgreiche Absolvieren des Moduls ermöglicht den Studierenden den sicheren Umgang mit mathematischen Anwendersystemen. Die Studierenden • erwerben die Befähigung zum sicheren Umgang mit mathematischen Anwendersystemen, • erfassen die Grundprinzipien der Programmierung, • sammeln Erfahrungen mit elementaren Algorithmen und deren Anwendungen, • verstehen die Grundlagen der Programmierung in einer high-level Programmiersprache, • lernen Kontroll- und Datenstrukturen kennen, • erlernen die Grundzüge des imperativen und funktionalen Programmierens, • setzen Bibliotheken zur Lösung naturwissenschaftlicher Fragestellungen ein, • erlernen verschiedene Methoden der Visualisierung, • beherrschen die Grundtechniken der Projektverwaltung (Versionskontrolle, Arbeiten im Team). **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Techniken für das Lösen mathematisch/physikalischer Problemstellungen mit der Hilfe einer high-level Programmiersprache erlernt.	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

Lehrveranstaltung: Blockkurs *Inhalte*: Blockkurs bestehend aus Vorlesung, Übungen und Praktikum, z.B. "Mathematisch orientiertes Programmieren"	2 SWS
Prüfung: Klausur (90 Minuten) oder mündliche Prüfung (ca. 20 min)	6 C

Prüfungsanforderungen: Nachweis über den Erwerb der folgenden Kenntnisse und Fähigkeiten. Die Teilnehmer/innen weisen grundlegende Techniken für das Lösen mathematisch/physikalischer Problemstellungen mit der Hilfe einer Programmiersprache nach.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0011, B.Mat.0012
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	Bachelor: 1 - 6; Master: 1 - 4
Maximale Studierendenzahl: 120	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0730: Praktikum Wissenschaftliches Rechnen** *English title: Practical course in scientific computing*	9 C 4 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls besitzen die Studierenden praktische Erfahrungen im wissenschaftlichen Rechnen. Sie • erstellen größere Programmierprojekte in Einzel- oder Gruppenarbeit; • erwerben und festigen Programmierkenntnisse; • haben Erfahrungen mit grundlegenden Verfahren zur numerischen Lösung von mathematischen Problemen. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • mathematische Algorithmen und Verfahren in einer Programmiersprache oder einem Anwendersystem zu implementieren; • spezielle numerische Bibliotheken zu nutzen; • komplexe Programmieraufgaben so zu strukturieren, dass sie effizient in Gruppenarbeit bewältigt werden können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 214 Stunden
Lehrveranstaltung: Praktikum Wissenschaftliches Rechnen	4 SWS
Prüfung: Präsentation (ca. 30 Minuten) oder Hausarbeit (max. 50 Seiten ohne Anhänge) **Prüfungsvorleistungen:** Regelmäßige Teilnahme im Praktikum	9 C
Prüfungsanforderungen: • Grundkenntnisse der numerischen Mathematik • gute Programmierkenntnisse	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0721, B.Mat.1300 Kenntnis des objektorientierten Programmierens
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0740: Stochastisches Praktikum** *English title: Practical course in stochastics*	9 C 6 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit den grundlegenden Eigenschaften und Methoden einer stochastischen Simulations- und Analyse-Software (z.B. “R” oder Matlab) vertraut. Sie haben in Projektarbeit Spezialkenntnisse in Stochastik erworben. Sie • implementieren und interpretieren selbstständig einfache stochastische Problemstellungen in einer entsprechenden Software; • schreiben selbständig einfache Progamme in der entsprechenden Software; • beherrschen einige grundlegende Techniken der statistischen Datenanalyse und stochastischen Simulation, wie etwa der deskriptiven Statistik, der linearen, nichtlinearen und logistischen Regression, der Maximum-Likelihood-Schätzmethode, sowie von verschiedenen Testverfahren und Monte-Carlo-Simulationsmethoden. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage • eine stochastische Simulations- und Analyse-Software auf konkrete stochastische Problemstellungen anzuwenden und die erhaltenen Resultate fachgerecht zu präsentieren; • statistische Daten und ihre wichtige Eigenschaften adäquat zu visualisieren und interpretieren.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden
Lehrveranstaltung: Stochastisches Praktikum	6 SWS
Prüfung: Präsentation (ca. 45 Minuten) mit schriftlicher Ausarbeitung (max. 50 Seiten ohne Anhänge)	9 C
Prüfungsanforderungen: Weiterführende Kenntnisse in Stochastik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.2410
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:
Dozent/in: Lehrpersonen des Instituts für Mathematische Stochastik

Georg-August-Universität Göttingen **Modul B.Mat.0910: Linux effektiv nutzen** *English title: Effective use of Linux*	3 C (Anteil SK: 3 C) 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Das UNIX-Derivat Linux ist mit Abstand das meistgenutzte Betriebssystem, allerdings nicht auf dem Desktop, sondern in Mobiltelefonen, auf Heimgeräten und auf Servern. Auch MAC-Systeme beruhen auf einem UNIX-System. Diese Modul biete eine Einführung in Grundlagen des Systems und der Netzwerkanbindung von Linux. Der Schwerpunkt liegt in der Nutzung von Linux und der Automation von Aufgaben auf der Commandline. Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über fundierte Grundlagenkenntnisse in folgenden Bereichen: • Linux als Einzelsystem; • Linux im Netzwerk; • Automatisierung von Aufgaben mit Shellskripten. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage • wesentlichen Abläufe im Linuxsystem zu verstehen; • mit einem Mehrbenutzerbetriebssystem auf der Ebene einfacher Systemverwaltung im Einzel- und im Netzwerkbetrieb umzugehen; • Skripte zur effektiven Aufgabenbewältigung zu erstellen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Vorlesung mit integrierten Übungen	2 SWS
Prüfung: Klausur (90 Minuten), unbenotet **Prüfungsvorleistungen:** B.Mat.0910.Ue: Erreichen von mindestens 50% der Übungspunkte	3 C

Prüfungsanforderungen: Grundkenntnisse in der Erstellung von Skripten im Einzel- und Netzwerkbetrieb, sicherer Umgang mit und Zuordnung von Begriffen aus einem Mehrbenutzerbetriebssystem im Einzel- und Netzwerkbetrieb.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Sicherer Umgang mit einem Computersystem
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts
- Schlüsselkompetenz im Bereich "EDV/IKT-Kompetenz (IKT=Informations- und Kommunikationstechnologie)", auch für Studierende anderer Fakultäten.

Georg-August-Universität Göttingen **Modul B.Mat.0921: Einführung in TeX/LaTeX und praktische Anwendungen** *English title: Introduction to TeX/LaTeX with applications*	3 C (Anteil SK: 3 C) 2 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit dem Einsatz von TeX oder LaTeX zur Erstellung von wissenschaftlichen Texten und Vorträgen vertraut. Sie • sind vertraut mit ordentlicher Dokumentengliederung; • erstellen Literaturangaben und Querverweise; • erzeugen mathematische Formeln; • erzeugen Grafiken und binden sie ein. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • einfache Dokumente mit LaTeX zu erstellen; • ansprechende Vortragsfolien mit LaTeX zu erzeugen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Blockkurs *Inhalte*: Einwöchige Blockveranstaltung mit Praktikum	
Prüfung: Hausarbeit (max. 10 Seiten), unbenotet **Prüfungsvorleistungen:** Regelmäßige Teilnahme an der Veranstaltung **Prüfungsanforderungen:** Erstellung eines wissenschaftlichen Portfolios mit TeX/LaTeX und der Folien für eine Präsentation mit Beamer-TeX.	3 C
Prüfungsanforderungen: Sicherer Umgang mit den grundlegenden Funktionen von LaTeX und Bearmer-TeX	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundkenntnisse im Umgang mit einem Computer.
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:
Dozent/in: Lehrpersonen des Mathematischen Instituts

Georg-August-Universität Göttingen **Module B.Mat.0922: Mathematics information services and electronic publishing**	3 C (incl. key comp.: 3 C) 2 WLH

Learning outcome, core skills: **Learning outcome:** After having successfully completed the module, students are familiar with the basics of mathematics information services and electronic publishing. They • work with popular information services in mathematics and with conventional, non-electronic as well as electronic media; • know a broad spectrum of mathematical information sources including classification principles and the role of meta data; • are familiar with current development in the area of electronic publishing in the subject mathematics. **Core skills:** After successfull completion of the module students have acquired subject-specific information competencies. They • have suitable research skills; • are familiar with different information and specific publication services.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture) *Contents*: Lecture course with project report	
Examination: Written examination (90 minutes), not graded **Examination prerequisites:** Regular participation in the course	3 C

Examination requirements: Application of the acquired skills in individual projects in the area of mathematical information services and electronic publishing	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dean of studies
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximum number of students: not limited	

Additional notes and regulations:

Instructors: Lecturers at the Mathematical Institute

<table>
<tr><td>Georg-August-Universität Göttingen
Module B.Mat.0923: Scientific Writing</td><td>3 C (incl. key comp.: 3 C)
2 WLH</td></tr>
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<table>
<tr><td>
Learning outcome, core skills:
Learning outcome:
After having successfully completed the module, students are familiar with the basics of scientific writing.
Objectives:

How to start; motivation for writing a paper (thesis, term paper, seminar presentation, conference talk); choice of language (German/English/?); when to start; support resources.
Different text types in the professional carreer, e.g. motivation letter, research report, technical report, proposal etc.
Plagiarism; different types of plagiarism, unintentional and intentional plagiarism; how to avoid and recognise plagiarism? How to avoid being accused of plagiarism?
Planning and execution, structure, overall style of language, clear and concise writing, writing problems and how to avoid them, cultural sensitivity, cultural transferability.
Discussion; purpose, content, tense, structure; introducing tense, voice and mood; introducing modular writing and why it helps.
Methods; purpose, content (Bishop report implications), tense, structure.
Results; purpose, content, tense, structure; what goes in figures, images and tables; effective placing and citation of figures, images, tables; warning on image manipulation.
Introduction; purpose, content, tense, structure.
Title, abstract, key words, search engine optimization, list of references, acknowledgements.
Optionally, choosing a journal, text matching, predatory & trick journals, your audience, factors affecting choice, scope, impact factors, open access.
Optionally, ethics of publication, COPE, Vancouver rules and other bodies, authorship, author order, contributorship statements, coauthors, corresponding authors, chaperones, grievance procedures.

Core skills:
After successfull completion of the module students have acquired subject-specific competencies in scientific writing. They

have suitable research skills;
are familiar with how to find and discuss a topic academically and using academic terms and methodology.

</td><td>
Workload:
Attendance time:
28 h
Self-study time:
62 h
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<table>
<tr><td>Course: Lecture course (Lecture)
Contents:
Lecture course with project report</td><td>2 WLH</td></tr>
</table>

Examination: Term Paper (max. 15 pages), not graded	3 C
Examination requirements: Application of the acquired skills in individual projects in the area of mathematical information services and electronic publishing	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dean of studies
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximum number of students: not limited	

Additional notes and regulations: **Instructors:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Modul B.Mat.0931: Tutorentraining** *English title: Coaching of teaching assistants*	4 C (Anteil SK: 4 C) 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit theoretischen und praktischen Fragestellungen der Vermittlung mathematischen Wissens vertraut. Sie werden befähigt, • mathematische Inhalte an Studierende im ersten Semester zu vermitteln; • eine heterogene Übungsgruppe zu leiten. • verschiedene Lehrmethoden und Visualisierungstechniken einzusetzen; • souverän aufzutreten. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • Rhetorik- und Präsentationstechniken einzusetzen; • Teamkompetenzen (insb. Motivationsfähigkeit und sicherer Umgang mit Konfliktsituationen) einzusetzen; • Methoden des Zeitmanagements zu verwenden; • interkulturelle Kompetenzen, insbesondere interkulturelle Kommunikationswege einzusetzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Integratives Projekt *Inhalte*: Neben dem Leiten einer Übungsgruppe während des gesamten Semesters oder einer Blockveranstaltung beinhaltet das Projekt ein Vorbereitungsseminar und ein Abschlussseminar sowie begleitende Kurzveranstaltungen.	
Prüfung: Präsentation [Übungsstunde] (ca. 45 Minuten) und schriftliche Ausarbeitung (max. 5 Seiten), unbenotet **Prüfungsvorleistungen:** Teilnahme an der Veranstaltung	4 C

Prüfungsanforderungen: Nachweis des Erreichens der Lernziele und Erwerbs der Kompetenzen durch Umsetzung in einer Übungsstunde	

Zugangsvoraussetzungen: Übertragung der Leitung einer Übungsgruppe zu einer Lehrveranstaltung der Fakultät für Mathematik und Informatik im gleichen Semester	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit:	**Dauer:**

jedes Wintersemester	1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Mathematischen Instituts

Georg-August-Universität Göttingen **Modul B.Mat.0932: Vermittlung mathematischer Inhalte an ein Fachpublikum** *English title: Communicating mathematical topics to a professional audience*	3 C (Anteil SK: 3 C) 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit theoretischen und praktischen Grundlagen der Vermittlung mathematischen Wissens vertraut. Sie • schätzen das Niveaus der Zielgruppe einer mathematischen Darbietung ein; • strukturieren Präsentationen gut; • beherrschen sicher stilistische und technische Aspekte der Darbietung; • wählen adäquate Hilfsmittel (z.B. zur Visualisierung); • steuern die Diskussion mit dem Publikum. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über je nach Veranstaltung verschiedene Kommunikations- und Vermittlungskompetenzen sowie ggf. Fremdsprachenkompetenzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Veranstaltung mit theoretischem und praktischem Anteil, kann ggf. als Blockveranstaltung angeboten werden oder als Teil eines mathematischen Seminars. (Seminar)	
Prüfung: Präsentation (45 Minuten), unbenotet **Prüfungsvorleistungen:** Teilnahme an der Veranstaltung	3 C

Prüfungsanforderungen: Nachweis des Erreichens der Lernziele durch Anfertigen einer Darbietung zur Vermittlung mathematischer Inhalte (Format der Darbietung je nach Veranstaltung)	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: keine Angabe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen der Lehreinheit Mathematik

Georg-August-Universität Göttingen	4 C (Anteil SK: 4 C) 2 SWS
Modul B.Mat.0935: Historische, museumspädagogische und technische Aspekte für den Aufbau, Erhalt und die Nutzung wissenschaftlicher Modellsammlungen *English title: Historical, museum-related, and technical aspects of the building-up, the maintenance and the use of scientific collections*	

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über Kenntnisse des Planens und Gestaltens von Mathematikunterricht und mathematikdidaktischen Forschungsprojekten **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls nutzen die Studierenden Kenntnisse der mathematischen Wissensvermittlung. Sie • ordnen wissenschaftliche Modellsammlungen in ihren historischen Kontext ein, • nutzen museumspädagogische Ansätze für die Vermittlung mit Hilfe von Objekten, • kennen Beispiele für Techniken, die für den Aufbau und Erhalt von Objekten in Modellsammlungen erforderlich sind.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Seminar	2 SWS
Prüfung: Portfolio (max. 5000 Zeichen), unbenotet	4 C

Prüfungsanforderungen: Erarbeitung historischer, museumspädagogischer und technischer Aspekte eines Modells oder mehrerer Modelle in Kontexten von Sammlungen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: keine Angabe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Mathematischen Instituts

Georg-August-Universität Göttingen **Modul B.Mat.0936: Medienbildung zu mathematischen Objekten und Problemen** *English title: Media education for mathematical objects and problems*	4 C (Anteil SK: 4 C) 2 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele: Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über Kenntnisse des Medienunterstützen Lehrens und Lernens zu mathematischen Objekten und Problemen. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls ordnen die Studierenden wissenschaftliche Modellsammlungen in ihren historischen Kontext ein. Sie • nutzen Kenntnisse der Medienbildung zur mathematischen Wissensvermittlung, • vergleichen unterschiedliche Designs für die Illustration mathematischer Objekte und Probleme, • implementieren beispielhaft unterschiedliche medientechnische Realisierungen mathematischer • Objekte.	Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Seminar	2 SWS
Prüfung: Portfolio (max. 5000 Zeichen), unbenotet	4 C

Prüfungsanforderungen: Erarbeitung medienbezogener Aspekte eines Modells oder mehrerer Modelle in Kontexten von Sammlungen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: keine Angabe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:
Dozent/in: Lehrpersonen des Mathematischen Instituts

Georg-August-Universität Göttingen **Modul B.Mat.0940: Mathematik in der Welt, in der wir leben** *English title: The mathematical nature of the world we are living in*	3 C (Anteil SK: 3 C) 2 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit der Rolle der Mathematik in unserer Gesellschaft vertraut, wobei die Schwerpunktsetzung je nach Veranstaltung ausgestaltet wird. Die Studierenden • entwickeln ein stärkeres Bewusstsein für die Rolle der Mathematik in anderen Fachdisziplinen; • erwerben ein tieferes Verständnis für die Bedeutung der Mathematik für den (technologischen) Fortschritt; • erkennen die Bedeutung der Mathematik für das Verständnis von Vorgängen und Erscheinungen in der Natur; • verstehen die Rolle der Mathematik in der Gesellschaft. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über verschiedene Kompetenzen, je nach Ausgestaltung der Lehrveranstaltung haben sie • ihre Befähigung zum Logischen Denken ausgebaut; • das mathematische Interpretieren von Observationen und Daten in einem außermathematischem Kontext erlernt; • die Transferfähigkeit von abstraktem Wissen auf reelle Situationen erworben; • ihre Methodenkompetenz im mathematischen Bereich gestärkt.	Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Vorlesung oder Seminar	
Prüfung: Klausur (90 Minuten) oder Hausarbeit (max. 10 Seiten), unbenotet	3 C

Prüfungsanforderungen: Nachweis des Erreichens der Lernziele durch Anwendung auf ausgewählte Problemstellungen	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jährlich	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:
Dozent/in: Lehrpersonen der Lehreinheit Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0950: Mitgliedschaft in der studentischen oder akademischen Selbstverwaltung** *English title: Membership in the student or academic self-government*	3 C (Anteil SK: 3 C) 1 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben zentrale Kompetenzen der Planung, Organisation, Präsentation sowie Grundkenntnisse in der Projektplanung. Sie erwerben Kompetenzen in Rhetorik, in Selbstpräsentation und in freier Rede. Im Praxisteil erlangen die Studierenden vertiefte Kenntnisse in den Bereichen Moderationstechniken, Gesprächsführung sowie Entscheidungs- und Konfliktlösungsverhalten in Gruppen.	**Arbeitsaufwand:** Präsenzzeit: 14 Stunden Selbststudium: 76 Stunden
Lehrveranstaltung: Gremienveranstaltung	
Prüfung: Hausarbeit (max. 5 Seiten), unbenotet	3 C
Prüfungsanforderungen: Die Studierenden erbringen den Nachweis der Befähigung, dass sie Erfahrungen aus der Praxis mit theoretischen Wissen verknüpfen und Methoden der Reflektion anwenden können.	

Zugangsvoraussetzungen: Mitgliedschaft in mindestens einem der folgenden Gremien: 1. Fakultätsrat der Fakultät für Mathematik und Informatik oder eine seiner Kommissionen 2. Senat der Universität oder einer seiner Kommissionen 3. Vorstand des Studentenwerks 4. Vorstand eines Instituts des Bereichs Mathematik	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Studiendekan/in Mathematik oder Studienreferent/in Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0951: Ehrenamtliches Engagement in einem mathematischen Umfeld** *English title: Civic engagement in a mathematical environment*	3 C (Anteil SK: 3 C) 1 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben zentrale Kompetenzen der Planung, Organisation, Präsentation sowie Grundkenntnisse in der Projektplanung. Sie erwerben Kompetenzen in Rhetorik, in Selbstpräsentation und in freier Rede. Im Praxisteil erlangen die Studierenden vertiefte Kenntnisse in mathematischer Wissensvermittlung sowie in mindestens einem der folgenden Bereichen: • Moderationstechniken, • Gesprächsführung • Entscheidungs- und Konfliktlösungsverhalten in Gruppen.	**Arbeitsaufwand:** Präsenzzeit: 14 Stunden Selbststudium: 76 Stunden
Lehrveranstaltung: Projektarbeit	
Prüfung: Portfolio (max. 5 Seiten), unbenotet	3 C
Prüfungsanforderungen: Die Studierenden erbringen den Nachweis der Befähigung, dass sie Erfahrungen aus der Praxis mit theoretischen Wissen verknüpfen und Methoden der Reflektion anwenden können.	

Zugangsvoraussetzungen: Ehrenamtliche Tätigkeit ohne Entgelt oder Aufwandsentschödigung, z.B. 1. bei der Durchführung der Mathematik-Olympiade oder dem Bundeswettbewerb Mathematik 2. Nachhilfe im Rahmen von sozialen Projekten 3. Mathematisches Korrespondenz-Zirkel 4. MatheCamp	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:
Dozent/in: Studiendekan/in Mathematik oder Studienreferent/in Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0952: Organisation einer mathematischen Veranstaltung** *English title: Event management in mathematics*	3 C (Anteil SK: 3 C) 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit Problemen, die bei der Organisation einer mathematischen Veranstaltung entstehen, vertraut. Dabei wird die Schwerpunktsetzung je nach dem zu organisierenden Veranstaltungsprojekt ausgestaltet, zu dem die Studierenden einen abgegrenzten, aktiven Beitrag leisten. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über verschiedene Kompetenzen, je nach Ausgestaltung des Veranstaltungsprojekts erwerben sie • Organisations- und Managementkompetenzen; • Kompetenzen im Informations- und Zeitmanagement; • Teamkompetenz.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Integratives Projekt *Inhalte*: *Angebotshäufigkeit:* jährlich	
Prüfung: Projektpräsentation (ca. 20 Minuten) oder Hausarbeit (max. 5 Seiten), unbenotet	3 C

Prüfungsanforderungen: Nachweis der Kompetenzen und Fähigkeiten durch einen abgegrenzten, aktiven Beitrag zu einem Veranstaltungsprojekt.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: keine Angabe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen der Lehreinheit Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0970: Betriebspraktikum** *English title: Internship*	8 C (Anteil SK: 8 C)

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls besitzen die Studierenden Kompetenzen in projektbezogener und forschungsorientierter Teamarbeit sowie im Projektmanagement. Sie sind mit Verfahren, Werkzeugen und Prozessen der Mathematik sowie dem organisatorischen und sozialen Umfeld der Praxis vertraut.	**Arbeitsaufwand:** Präsenzzeit: 0 Stunden Selbststudium: 240 Stunden

Lehrveranstaltung: Prüfungskolloquium (Kolloquium)	
Prüfung: Präsentation (ca. 20 Minuten) mit schriftlicher Ausarbeitung (max. 10 Seiten), unbenotet **Prüfungsvorleistungen:** Bescheinigung über die erfolgreiche Erfüllung der gestellten Aufgaben gemäß Praktikumsplan	8 C

Prüfungsanforderungen: Erfolgreiche Bearbeitung der gestellten Aufgaben gemäß zwischen dem oder der Studierenden, der Lehrperson und dem Betrieb zu vereinbarendem Praktikumsplan	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:
Dozent/in: Lehrpersonen der Lehreinheit Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.1300: Numerische lineare Algebra** *English title: Numerical linear algebra*	9 C 6 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit Grundbegriffen und Methoden im Schwerpunkt "Numerische und Angewandte Mathematik" vertraut. Sie • gehen sicher mit Matrix- und Vektornormen um; • formulieren für verschiedenartige Fixpunktgleichungen einen geeigneten Rahmen, der die Anwendung des Banachschen Fixpunktsatzes erlaubt; • beurteilen Vor- und Nachteile von direkten und iterativen Lösungsverfahren für lineare Gleichungssysteme, insbesondere von Krylovraumverfahren, und analysieren die Konvergenz iterativer Verfahren; • lösen nichtlineare Gleichungssysteme mit dem Newtonverfahren und analysieren dessen Konvergenz; • formulieren quadratische Ausgleichsprobleme zur Schätzung von Parametern aus Daten und lösen sie numerisch; • berechnen numerisch Eigenwerte und -vektoren von Matrizen. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Kompetenzen im Schwerpunkt "Numerische und Angewandte Mathematik" erworben. Sie sind in der Lage, • grundlegende Verfahren zur numerischen Lösung von mathematischen Problemen anzuwenden; • numerische Algorithmen in einer Programmiersprache oder einem Anwendersystem zu implementieren; • Grundprinzipien der Konvergenzanalysis numerischer Algorithmen zu nutzen.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden
Lehrveranstaltung: Numerische Mathematik I (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.1300.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C
Lehrveranstaltung: Numerische Mathematik I - Übung (Übung)	2 SWS
Prüfungsanforderungen: Nachweis der Grundkenntnisse der numerischen und angewandten Mathematik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache:	**Modulverantwortliche[r]:**

Deutsch	Studiendekan*in
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 5
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik
- Universitätsweites Schlüsselkompetenzangebot; als solches nicht verwendbar für Studierende im Zwei-Fächer-Bachelor Studiengang mit Fach Mathematik, Studiengang Master of Education mit Fach Mathematik, Bachelor/Master-Studiengang Mathematik und Promotionsstudiengang Mathematical Sciences.

Georg-August-Universität Göttingen **Modul B.Mat.1310: Methoden zur Numerischen Mathematik** *English title: Methods for numerical mathematics*	4 C 2 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit weiterführenden numerischen Methoden zum Modul "Grundlagen der Numerischen Mathematik“ vertraut. Je nach aktuellem Lehrangebot unterschiedlich geordnet und gewichtet werden folgende inhaltsbezogenen Kompetenzen angestrebt. Die Studierenden • gehen sicher mit numerischen Algorithmen zu linearen und nichtlinearen Gleichungssystemen um; • formulieren für verschiedenartige Probleme aus der angewandten Mathematik Darstellungen und Modelle, die mit Hilfe eines numerischen Verfahrens aus dem Modul "Grundlagen der Numerischen Mathematik“ gelöst werden können; • beurteilen Vor- und Nachteile von direkten und iterativen Lösungsverfahren für lineare Gleichungssysteme, insbesondere von Krylovraum-Verfahren; • analysieren und bewerten fortgeschrittene Newton-artige Verfahren hinsichtlich Konvergenzgeschwindigkeit und Komplexität und wenden sie auf nichtlineare Gleichungssysteme aus der Praxis an; • formulieren quadratische Ausgleichsprobleme zur Schätzung von Parametern aus Daten und lösen sie numerisch; • berechnen Eigenwerte und -vektoren von Matrizen mit forgeschrittenen Verfahren wie effizienten Implementationen des QR-Verfahrens oder Krylovraum-Verfahren. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden vertiefte Erfahrungen in der praktischen Umsetzung numerischer Algorithmen erworben. Sie • haben Erfahrungen mit grundlegenden Verfahren zur numerischen Lösung von mathematischen Problemen; • implementieren numerische Algorithmen in einer Programmiersprache oder einem Anwendersystem; • sind mit Grundprinzipien der Konvergenzanalysis numerischer Algorithmen vertraut und unterscheiden die Stärken der verschiedenen Verfahren.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Vorlesung "Methoden zur Numerischen Mathematik" mit Übungen Blockveranstaltung, alternativ parallel zur Vorlesung "Numerische Mathematik I" (B.Mat.1300)	2 SWS
Prüfung: Klausur (45 Minuten) oder mündliche Prüfung (ca. 15 Minuten)	4 C
Prüfungsanforderungen: Nachweis grundlegender Kenntnisse der behandelten Methoden	

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**

keine	B.Mat.0021, B.Mat.0022
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jährlich nach Bedarf WiSe oder SoSe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen Modul B.Mat.1400: Maß- und Wahrscheinlichkeitstheorie *English title: Measure and probability theory*	9 C 6 SWS

Lernziele/Kompetenzen:

Lernziele:

Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit den Grundbegriffen und Methoden der Maßtheorie sowie auch der Wahrscheinlichkeitstheorie vertraut, die die Grundlage des Schwerpunkts "Mathematische Stochastik" bilden. Sie

- kennen die wichtigsten elementaren stochastischen Grundmodelle und Verteilungen von Zufallsvariablen;
- verstehen grundlegende Eigenschaften sowie Existenz und Eindeutigkeitsaussagen von Maßen;
- gehen sicher mit allgemeinen Maß-Integralen um, insbesondere mit dem Lebesgue-Integral;
- kennen sich mit Lp-Räumen und Produkträumen aus;
- formulieren wahrscheinlichkeitstheoretische Aussagen mit Wahrscheinlichkeitsräumen, Wahrscheinlichkeitsmaßen und Zufallsvariablen;
- rechnen und modellieren mit stetigen und mehrdimensionalenVerteilungen;
- beschreiben Wahrscheinlichkeitsmaße mit Hilfe von Verteilungsfunktionen bzw. Dichten;
- verstehen und nutzen das Konzept der Unabhängigkeit;
- berechnen Erwartungswerte von Funktionen von Zufallsvariablen;
- verstehen die verschiedenen stochastischen Konvergenzbegriffe und ihre Beziehungen;
- kennen charakteristische Funktionen und deren Anwendungen;
- besitzen Grundkenntnisse über bedingte Wahrscheinlichkeiten und bedingte Erwartungswerte;
- verwenden und beweisen das schwache Gesetz der großen Zahlen und den zentralen Grenzwertsatz;
- kennen einfache stochastische Prozesse wie z.B. Markov-Ketten.

Kompetenzen:

Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Kompetenzen im Schwerpunkt "Mathematische Stochastik" erworben. Sie sind in der Lage,

- Maßräume und Maß-Integrale anzuwenden;
- stochastische Denkweisen einzusetzen und einfache stochastische Modelle zu formulieren;
- stochastische Modelle mathematisch zu analysieren;
- die wichtigsten Verteilungen zu verstehen und anzuwenden;
- stochastische Abschätzungen mit Hilfe von Wahrscheinlichkeitsgesetzen durchzuführen;

Arbeitsaufwand:

Präsenzzeit:

84 Stunden

Selbststudium:

186 Stunden

• grundlegende Grenzwertsätze der Wahrscheinlichkeitstheorie zu verwenden und zu beweisen.	

Lehrveranstaltung: Maß- und Wahrscheinlichkeitstheorie (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.1400.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Lehrveranstaltung: Maß- und Wahrscheinlichkeitstheorie - Übung (Übung)	2 SWS

Prüfungsanforderungen: Nachweis von Grundkenntnissen in diskreter Stochastik sowie Maß- und Wahrscheinlichkeitstheorie	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 5
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent*in: Lehrpersonen des Instituts für Mathematische Stochastik

Georg-August-Universität Göttingen **Modul B.Mat.2110: Funktionalanalysis** *English title: Functional analysis*	9 C 6 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit funktionalanalytischer Denkweise und den zentralen Resultaten aus diesem Gebiet vertraut. Sie • gehen sicher mit den gängigsten Beispielen von Funktionen- und Folgenräumen wie Lp, lp und Räumen stetiger Funktionen um und analysieren deren funktionalanalytische Eigenschaften; • wenden die grundlegenden Sätze über lineare Operatoren in Banach-Räumen an, insbesondere die Sätze von Banach-Steinhaus, Hahn-Banach und den Satz über die offene Abbildung; • argumentieren mit schwachen Konvergenzbegriffen und den grundlegenden Eigenschaften von Dual- und Bidualräumen; • erkennen Kompaktheit von Operatoren und analysieren die Lösbarkeit linearer Operatorgleichungen mit Hilfe der Riesz-Fredholm-Theorie; • sind mit grundlegenden Begriffen der Spektraltheorie und dem Spektralsatz für beschränkte, selbstadjungierte Operatoren vertraut. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • in unendlich-dimensionalen Räumen geometrisch zu argumentieren; • Aufgabenstellungen in funktionalanalytischer Sprache zu formulieren und zu analysieren; • die Relevanz funktionalanalytischer Eigenschaften wie der Wahl eines passenden Funktionenraums, Vollständigkeit, Beschränktheit oder Kompaktheit zu erkennen und zu beschreiben.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden
Lehrveranstaltung: Funktionalanalysis (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2110.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C
Lehrveranstaltung: Funktionalanalysis - Übung (Übung)	2 SWS
Prüfungsanforderungen: Nachweis der Grundkenntnisse über Funktionalanalysis	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache:	**Modulverantwortliche[r]:**

Englisch, Deutsch	Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts oder des Instituts für Numerische und Angewandte Mathematik
- Ausschlüsse: Dieses Modul darf nicht in dem Studiengang "Master of Education", Fach Mathematik, eingebracht werden, wenn im Bachelor-Studium bereits eines der nachstehenden Module eingebracht wurde:
  - B.Mat.1100 „Analysis auf Mannigfaltigkeiten“
  - B.Mat.2110 „Funktionalanalysis“
  - B.Mat.2120 „Funktionentheorie“
  - B.Mat.2100 „Partielle Differenzialgleichungen“
  - B.Mat.0030 „Gewöhnliche Differenzialgleichungen“

Georg-August-Universität Göttingen **Modul B.Mat.2220: Diskrete Mathematik** *English title: Discrete mathematics*	9 C 6 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit Grundbegriffen und Methoden der diskrete Mathematik vertraut. Sie • erwerben grundlegende Kenntnisse über diskrete Mathematik, insbesondere über enumerative Kombinatorik, erzeugende Funktionen, Rekursionen und asymptotische Analyse; • erlernen algebraische Grundlagen der diskreten Mathematik, insbesondere üben sie den Umgang mit endlichen Gruppen und Körpern; • sind mit Graphen, Bäumen, Netzwerken und Suchtheorien vertraut; • kennen grundlegende Aspekte der spektralen Graphentheorie, z.B. Laplace-Matrix, Fiedler-Vektoren, Laplacian-Einbettung, spectral clustering und Cheeger-Schnitte. Je nach Bedarf und konkreter Ausgestaltung der Vorlesung erwerben die Studierenden vertiefte Kenntnisse der diskreten Mathematik, z.B. • im Bereich Zahlentheorie über Kryptographie, Gitter, Codes, Kugelpackungen; • im Bereich algebraische Strukturen über Boolesche Algebra, Matroide, schnelle Matrixmultiplikation; • im Bereich Geometrie über diskrete Geometrie und Polytope. **Kompetenzen**: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • elementare Denkweisen und Beweistechniken der diskreten Mathematik zu beherrschen; • mit Grundbegriffen und grundlegenden Methoden der diskreten Mathematik zu argumentieren; • mit Begriffen und Methoden aus weiterführenden Themen der diskreten Mathematik zu arbeiten.	Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Diskrete Mathematik (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2220.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Lehrveranstaltung: Diskrete Mathematik - Übung (Übung)	2 SWS

Prüfungsanforderungen: Nachweis der Grundkenntnisse der diskreten Mathematik	

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**

keine	B.Mat.0021, B.Mat.0022
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 5
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts
- Ausschlüsse: Dieses Modul darf nicht in dem Studiengang "Master of Education", Fach Mathematik, eingebracht werden, wenn im Bachelor-Studium bereits eines der nachstehenden Module eingebracht wurde:
  - B.Mat.1200 „Algebra“
  - B.Mat.2210 „Zahlen und Zahlentheorie“
  - B.Mat.2220 „Diskrete Mathematik“

Georg-August-Universität Göttingen **Modul B.Mat.2300: Numerische Analysis** *English title: Numerical analysis*	9 C 6 SWS

Lernziele/Kompetenzen: Lernziele: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit weiterführenden Begriffen und Methoden im Schwerpunkt "Numerische und angewandte Mathematik" vertraut. Sie • interpolieren vorgegebene Stützpunkte mit Hilfe von Polynomen, trigonometrischen Polynomen und Splines; • integrieren Funktionen numerisch mit Hilfe von Newton-Cotes Formeln, Gauß-Quadratur und Romberg-Quadratur; • modellieren Evolutionsprobleme mit Anfangswertaufgaben für Systeme von gewöhnlichen Differenzialgleichungen, lösen diese numerisch mit Runge-Kutta-Verfahren und analysieren deren Konvergenz; • erkennen die Steifheit von gewöhnlichen Differenzialgleichungen und lösen entsprechende Anfangswertprobleme mit impliziten Runge-Kutta-Verfahren; • lösen je nach Ausrichtung der Veranstaltung Randwertprobleme oder sind mit Computer Aided Graphic Design (CAGD), Grundlagen der Approximationstheorie oder anderen Gebieten der Numerischen Mathematik vertraut. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage • Algorithmen zur Lösung mathematischer Probleme zu entwickeln und • deren Stabilität, Fehlerverhalten und Komplexität abzuschätzen.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Numerische Mathematik II	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2300.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Lehrveranstaltung: Numerische Mathematik II - Übung	2 SWS

Prüfungsanforderungen: Nachweis weiterführender Kenntnisse in numerischer Mathematik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.1300
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.2310: Optimierung** *English title: Optimisation*	9 C 6 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit Grundbegriffen und Methoden der Optimierung vertraut. Sie • lösen lineare Optimierungsprobleme mit dem Simplex-Verfahren und sind mit der Dualitätstheorie der linearen Optimierung vertraut; • beurteilen Konvergenzeigenschaften und Rechenaufwand von grundlegenden Verfahren für unrestringierte Optimierungsprobleme wie Gradienten- und (Quasi-)Newton-Verfahren; • kennen Lösungsverfahren für nichtlineare, restringierte Optimierungsprobleme und gehen sicher mit den KKT-Bedingungen um; • modellieren Netzwerkflussprobleme und andere Aufgaben als ganzzahlige Optimierungsprobleme und erkennen totale Unimodularität. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • Optimierungsaufgaben in der Praxis zu erkennen und als mathematische Programme zu modellieren sowie • geeignete Lösungsverfahren zu erkennen und zu entwickeln.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Übungen *Angebotshäufigkeit:* jedes Wintersemester	2 SWS

Lehrveranstaltung: Vorlesung (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2310.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Prüfungsanforderungen: Nachweis der Grundkenntnisse der Optimierung	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6

Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik
- Universitätsweites Schlüsselkompetenzangebot; als solches nicht verwendbar für Studierende im Zwei-Fächer-Bachelor Studiengang mit Fach Mathematik, Studiengang Master of Education mit Fach Mathematik, Bachelor/Master-Studiengang Mathematik und Promotionsstudiengang Mathematical Sciences.

Georg-August-Universität Göttingen **Modul B.Mat.2410: Stochastik** *English title: Stochastics*	9 C 6 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit fortgeschrittenen Begriffen und Denkweisen der mathematischen Stochastik vertraut. Sie • beherrschen weiterführende Konzepte der Maßtheorie; • beherrschen bedingte Erwartungswerte; • verstehen gleichgradige Integrierbarkeit; • lösen stochastische Probleme mittels Wahrscheinlichkeitsungleichungen und dem (multivariaten) zentralen Grenzwertsatz; • verstehen das starke Gesetz der großen Zahlen (für Martingale); • kennen verschiedene Modellklassen stochastischer Prozesse wie z.B. Martingale und die Brownsche Bewegung und verstehen deren wichtigste Eigenschaften; • simulieren Zufallsvariablen elementar und mit Markov-Ketten; • beherrschen die Grundlagen moderner mathematischer Statistik **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage • fortgeschrittene stochastische Denkweisen und Beweistechniken anzuwenden; • stochastische Problemstellungen über Wahrscheinlichkeitsräume und Zufallsvariablen zu modellieren und zu analysieren; • Grenzwertsätze der fortgeschrittenen Wahrscheinlichkeitstheorie zu verwenden; • die Eigenschaften verschiedener Modellklassen stochastischer Prozesse wie z.B. Martingale und die Brownsche Bewegung zu verstehen und zu beweisen; • stochastische Problemstellungen mit Hilfe von stochastischen Prozessen zu modellieren und analysieren.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden
Lehrveranstaltung: Stochastik (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2410.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C
Lehrveranstaltung: Stochastik - Übung (Übung)	2 SWS
Prüfungsanforderungen: Nachweis fortgeschrittener Kenntnisse in Wahrscheinlichkeitstheorie und mathematischer Statistik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.1400
Sprache:	**Modulverantwortliche[r]:**

Deutsch	Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent*in: Lehrpersonen des Instituts für Mathematische Stochastik

Georg-August-Universität Göttingen Modul B.Mat.2420: Statistical Data Science *English title: Statistical Data Science*	9 C 6 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit Methoden und Denkweisen der Statistical Data Science vertraut. Sie • modellieren diskrete Wahrscheinlichkeitsräume, beherrschen die damit verbundene Kombinatorik sowie den Einsatz von Unabhängigkeit und bedingten Wahrscheinlichkeiten; • gehen sicher mit den Grundbegriffen der deskriptiven Methoden der Statistical Data Science um wie etwa Histogrammen, Quantilen und anderen Kenngrößen von Verteilungen; • kennen für die Statistical Data Science relevante Verteilungen von diskreten und stetigen Zufallsvariablen; • erlernen grundlegende Algorithmen zur Erzeugung von Zufallszahlen und Computersimulationen; • verstehen elementare stochastische Beweistechniken und ihre Verwendung in der Statistical Data Science; • sind vertraut mit elementaren Schätzprinzipien wie etwa Maximum-Likelihood-Schätzer, Momentenschätzer und Bayes-Schätzer und kennen ihre elementaren statistischen Eigenschaften; • sind mit den zentralen Begrifflichkeiten zur Bewertung des Risikos dieser Schätzer vertraut; • erlernen algorithmische Verfahren der Statistical Data Science zur Berechnung dieser Schätzer; • sind mit grundlegenden mathematischen Methoden der Statistical Data Science vertraut, wie etwa Cluster-, Hauptkomponenten- und Regressionsanalyse. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Kompetenzen im Bereich Statistical Data Science erworben. Sie sind in der Lage, • statistische Denkweisen und deskriptive Methoden der Statistical Data Science anzuwenden und diese mathematisch zu analysieren; • elementare stochastische Modelle der Statistical Data Science zu formulieren; • grundlegende Schätzmethoden zu verwenden und einfache Verfahren zur Cluster- und Regressionsanalyse mathematisch zu verstehen und durchzuführen; • konkrete Datensätze zu analysieren und entsprechende Verfahren der Statistical Data Science einzusetzen.	Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Statistical Data Science (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:**	9 C

B.Mat.2420.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	

Lehrveranstaltung: Statistical Data Science - Übung (Übung)	2 SWS

Prüfungsanforderungen: Nachweis weiterführender Kenntnisse in Statistical Data Science	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0011, B.Mat.0012
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent*in: Lehrpersonen des Instituts für Mathematische Stochastik
- Universitätsweites Schlüsselkompetenzangebot

Georg-August-Universität Göttingen **Modul B.Mat.3031: Wissenschaftliches Rechnen** *English title: Scientific computing*	6 C 4 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden • Grundwissen zu numerischen Verfahren in einem ausgewählten aktuellen Gebiet des wissenschaftlichen Rechnens erworben; • beispielbezogene Erfahrungen zur Anwendung dieser numerischen Verfahren in dem ausgewählten aktuellen Gebiet des wissenschaftlichen Rechnens und ihren theoretischen Hintergründen gesammelt. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden weitergehende Kompetenzen im Schwerpunkt "Numerische und Angewandte Mathematik" erworben. Sie sind in der Lage, • numerische Verfahren des ausgewählten aktuellen Gebietes des wissenschaftlichen Rechnens einzusetzen; • diese numerischen Algorithmen in einem Anwendersystem oder in einer geeigneten Programmiersprache zu implementieren; • elementare Aussagen zu Konvergenz und Komplexität der ausgewählten numerischen Algorithmen herzuleiten; • die ausgewählten numerischen Verfahren des Gebietes exemplarisch anzuwenden.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Weiterführende Vorlesung zu einem aktuellen Gebiet im Bereich der Verfahren des wissenschaftlichen Rechnens mit Übungen und/oder Praktikum	
Prüfung: Mündlich (ca. 20 Minuten) **Prüfungsvorleistungen:** B.Mat.3031.Ue: Teilnahme an Übungen/Praktikum und mündlicher Vortrag	6 C

Prüfungsanforderungen: Die Beherrschung der in der Veranstaltung behandelten Verfahren des wissenschaftlichen Rechnens, ihre Anwendbarkeit und Eigenschaften	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.1300
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: keine Angabe	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen Module B.Mat.3043: Non-life insurance mathematics	6 C 4 WLH

Learning outcome, core skills: Non-life insurance mathematics deals with models and methods of quantifying risks with both, the occurrence of the loss and its amount showing random patterns. In particular the following problems are to be solved: • determing appropriate insurance premiums; • calculate adequate loss reserves; • determine how to allocate risk between policyholder and insurer resp. insurer and reinsurers. The German Actuarial Association (Deutsche Aktuarvereinigung e. V.) has certified this module as element of the training as an actuary („Aktuar DAV“ / „Aktuarin DAV“, cf. www.aktuar.de). To this end, the course is designed in view of current legislative and regulatory provisions of the Federal Republic of Germany. **Learning outcome:** The aim of the module is to equip students with knowledge in four areas: 1. risk models; 2. pricing; 3. reserving; 4. risk sharing. After having successfully completed the module, students are familiar with fundamental terms and methods of non-life insurance mathematics. They • are familiar with and able to handle essential definitions and terms within non-life insurance mathematics; • have an overview of the most valuable problem statements of non-life insurance; • understand central aspects of risk theory; • know substantial pricing and reserving methods; • estimate ruin probabilities; • are acquainted with most important reinsurance forms and reinsurance pricing methods. **Core skills:** After having successfully completed the module, students have acquired fundamental competencies within non-life insurance. They are able to • evaluate and quantify fundamental risks; • model the aggregate loss with individual or collective model; • apply a basic inventory of solving approaches; • analyse and develop pricing models which mathematically are state of the art; • apply different reserving methods and calculate outstanding losses; • assess reinsurance contracts.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture course with exercise session	4 WLH

Examination: Written examination (120 minutes)	6 C
Examination requirements: Fundamental knowledge of non-life insurance mathematics	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations:

Instructor: External lecturers at the Institute of Mathematical Stochastics

Accreditation: By the German Actuarial Association (Deutsche Aktuarvereinigung e. V.), valid until winter semester 2017/18

Georg-August-Universität Göttingen **Module B.Mat.3044: Life insurance mathematics**	6 C 4 WLH

Learning outcome, core skills: This module deals with the basics of different branches in life insurance mathematics. In particular, students get to know both the classical deterministic model and the stochastic model as well as how to apply them to problems relevant in the respective branch. On this base the students describe • essential notions of present values; • premiums and their present values; • the actuarial reserve. The German Actuarial Association (Deutsche Aktuarvereinigung e. V.) has certified this module as element of the training as an actuary („Aktuar DAV“ / „Aktuarin DAV“, cf. www.aktuar.de). To this end, the course is designed in view of current legislative and regulatory provisions of the Federal Republic of Germany. **Learning outcome:** After having successfully completed the module, students are familiar with fundamental terms and methods of life insurance mathematics. In particular they • assess cashflows in terms of financial and insurance mathematics; • apply methods of life insurance mathematics to problems from theory and practise; • characterise financial securities and insurance contracts in terms of cashflows; • have an overview of the most valuable problem statements of life insurance; • understand the stochastic interest structure; • master fundamental terms and notions of life insurance mathematics; • get an overwiew of most important problems in life insurance mathematics; • understand mortality tables and leaving orders within pension insurance; • know substantial pricing and reserving methods; • know the economic and legal requirements of private health insurance in Germany; • are acquainted with per-head loss statistics, present value factor calculation and biometric accounting principles. **Core skills:** After having successfully completed the module, students have acquired fundamental competencies within life insurance. They are able to • assess cashflows with respect to both collateral and risk under deterministic interest structure; • calculate premiums and provisions in life-, health- and pension-insurance; • understand the actuarial equivalence principle as base of actuarial valuation in life insurance; • apply and understand the actuarial equivalence principle for calculating premiums, actuarial reserves and ageing provisions; • calculate profit participation in life insurance; • master premium calculation in health insurance;	**Workload:** Attendance time: 56 h Self-study time: 124 h

• calculate present value and settlement value of pension obligations; • find mathematical solutions to practical questions in life, health and pension insurance.	

Course: Lecture course with exercises	4 WLH
Examination: Written examination (120 minutes)	6 C
Examination requirements: Fundamental knowledge of life insurance mathematics	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations:
Instructor: External lecturers at the Institute of Mathematical Stochastics

Accreditation: By the German Actuarial Association (Deutsche Aktuarvereinigung e. V.), valid until summer semester 2019

Georg-August-Universität Göttingen Module B.Mat.3131: Introduction to inverse problems	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Inverse problems" enables students to learn methods, concepts, theories and applications in the area of "Inverse problems". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the phenomenon of illposedness and identify the degree of illposedness of typical inverse problems; • evaluate different regularisation methods for ill posed inverse problems under algorithmic aspects and with regard to various a priori information and distinguish concepts of convergence for such methods with deterministic and stochastic data errors; • analyse the convergence of regularisation methods with the help of spectral theory of bounded self-adjoint operators; • analyse the convergence of regularisation methods with the help of complex analysis; • analyse regularisation methods from stochastic error models; • apply fully data-driven models for the choice of regularisation parameters and evaluate these for concrete problems; • model identification problems in natural sciences and technology as inverse problems of partial differential equations where the unknown is e. g. a coefficient, an initial or a boundary condition or the shape of a region; • analyse the uniqueness and conditional stability of inverse problems of partial differential equations; • deduce sampling and testing methods for the solution of inverse problems of partial differential equations and analyse the convergence of such methods; • formulate mathematical models of medical imaging like computed tomography (CT) or magnetic resonance tomography (MRT) and know the basic characteristics of corresponding operators. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Inverse problems"; • explain basic ideas of proof in the area "Inverse problems"; • illustrate typical applications in the area "Inverse problems".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: written examination (120 minutes) or oral examination (appr. 20 minutes)	9 C

Examination prerequisites: B.Mat.3131.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Inverse problems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3134: Introduction to optimisation	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Optimisation" enables students to learn methods, concepts, theories and applications in the area of "Optimisation", so the discrete and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • identify optimisation problems in application-oriented problems and formulate these as mathematical programmes; • evaluate the existence and uniqueness of the solution of an optimisation problem; • identify structural characteristics of an optimisation problem, amongst others the existence of a finite candidate set, the structure of the underlying level set; • know which special characteristics of the target function and the constraints (like (virtual) convexity, dc functions) for the development of solution strategies can be utilised; • analyse the complexity of an optimisation problem; • classify a mathematical programme in a class of optimisation problems and know current solution strategies for it; • develop optimisation methods and adapt general methods to special problems; • deduce upper and lower bounds for optimisation problems and understand their meaning; • understand the geometrical structure of an optimisation problem and apply it for solution strategies; • distinguish between proper solution methods, approximation methods with quality guarantee and heuristics and evaluate different methods on the basis of the quality of the found solutions and their computing times; • acquire advanced knowledge in the development of solution strategies on the basis of a special area of optimisation, e. g. integer optimisation, optimisation of networks or convex optimisation; • acquire advanced knowledge for the solution of special optimisation problems of an application-oriented area, e. g. traffic planning or location planning; • handle advanced optimisation problems, like e. g. optimisation problems with uncertainty or multi-criteria optimisation problems. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Optimisation"; • explain basic ideas of proof in the area "Optimisation"; • illustrate typical applications in the area "Optimisation".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3134.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Optimisation"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3137: Introduction to variational analysis	9 C 6 WLH

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Learning outcome, core skills:
Learning outcome:

The successful completion of modules of the cycle "Variational analysis" enables students to learn methods, concepts, theories and applications in variational analysis and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- understand basic concepts of convex and variational analysis for finite- and infinite-dimensional problems;
- master the characteristics of convexity and other concepts of the regularity of sets and functions to evaluate the existence and regularity of the solutions of variational problems;
- understand basic concepts of the convergence of sets and continuity of set-valued functions;
- understand basic concepts of variational geometry;
- calculate and use generalised derivations (subderivatives and subgradients) of non-smooth functions;
- understand the different concepts of regularity of set-valued functions and their effects on the calculation rules for subderivatives of non-convex functionals;
- analyse constrained and parametric optimisation problems with the help of duality theory;
- calculate and use the Legendre-Fenchel transformation and infimal convulutions;
- formulate optimality criteria for continuous optimisation problems with tools of convex and variational analysis;
- apply tools of convex and variational analysis to solve generalised inclusions that e. g. originate from first-order optimality criteria;
- understand the connection between convex functions and monotone operators;
- examine the convergence of fixed point iterations with the help of the theory of monotone operators;
- deduce methods for the solution of smooth and non-smooth continuous constrained optimisation problems and analyse their convergence;
- apply numerical methods for the solution of smooth and non-smooth continuous constrained programs to current problems;
- model application problems with variational inequations, analyse their characteristics and are familiar with numerical methods for the solution of variational inequations;
- know applications of control theory and apply methods of dynamic programming;
- use tools of variational analysis in image processing and with inverse problems;
- know basic concepts and methods of stochastic optimisation.

Core skills:

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Workload:
Attendance time:
84 h
Self-study time:
186 h

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After having successfully completed the module, students will be able to • discuss basic concepts of the area "Variational analysis"; • explain basic ideas of proof in the area "Variational analysis"; • illustrate typical applications in the area "Variational analysis".	

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) (120 minutes) **Examination prerequisites:** B.Mat.3137.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Variational analysis"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3138: Introduction to image and geometry processing	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Image and geometry processing" enables students to learn and apply methods, concepts, theories and applications in the area of "Image and geometry processing", so the digital image and geometry processing. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of problems of image and geometry processing in suitable finite- and infinite-dimensional vector spaces; • learn basic methods for the analysis of one- and multidimensional functions in Banach and Hilbert spaces; • learn basic mathematical concepts and methods that are used in image processing, like Fourier and Wavelet transform; • learn basic mathematical concepts and methods that play a central role in geometry processing, like curvature of curves and surfaces; • acquire knowledge about continuous and discrete problems of image data analysis and their corresponding solution strategies; • know basic concepts and methods of topology; • are familiar with visualisation software; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • know which special characteristics of an image or of a geometry can be extracted and worked on with which methods; • evaluate different numerical methods for the efficient analysis of multidimensional data on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear methods for the geometrical and topological analysis of multidimensional data; • are informed about current developments of efficient geometrical and topological data analysis; • adapt solution strategies for the data analysis using special structural characteristics of the given multidimensional data. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Image and geometry processing"; • explain basic ideas of proof in the area "Image and geometry processing"; • illustrate typical applications in the area "Image and geometry processing".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3138.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Image and geometry processing"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module B.Mat.3139: Introduction to scientific computing / applied mathematics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Scientific computing / applied mathematics" enables students to learn and apply methods, concepts, theories and applications in the area of "Scientific computing / Applied mathematics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of basic mathematical models of the corresponding subject area, especially about the existence and uniqueness of solutions; • know basic methods for the numerical solution of these models; • analyse stability, convergence and efficiency of numerical solution strategies; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • are informed about current developments of scientific computing, like e. g. GPU computing and use available soft- and hardware; • use methods of scientific computing for solving application problems, like e. g. of natural and business sciences. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Scientific computing / applied mathematics"; • explain basic ideas of proof in the area "Scientific computing / applied mathematics"; • illustrate typical applications in the area "Scientific computing / applied mathematics".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: written examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3139.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements:	

Proof of knowledge and mastery of basic competencies in the area "Scientific computing / applied mathematics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module B.Mat.3141: Introduction to applied and mathematical stochastics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Applied and mathematical stochastics" enables students to understand and apply a broad range of problems, theories, modelling and proof techniques of stochastics. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued: Students • are familiar with advanced concepts of probability theory established on measure theory and apply them independently; • are familiar with substantial concepts and approaches of probability modelling and inferential statistics; • know basic characteristics of stochastic processes as well as conditions for their existence and uniqueness; • have a pool of different stochastic processes in time and space at their disposal and characterise those, differentiate them and quote examples; • understand and identify basic characteristics of invariance of stochastic processes like stationary processes and isotropy; • analyse the convergence characteristic of stochastic processes; • analyse regularity characteristics of the paths of stochastic processes; • adequately model temporal and spatial phenomena in natural and economic sciences as stochastic processes, if necessary with unknown parameters; • analyse probabilistic and statistic models regarding their typical characteristics, estimate unknown parameters and make predictions for their paths on areas not observed / at times not observed; • discuss and compare different modelling approaches and evaluate the reliability of parameter estimates and predictions sceptically. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Applied and mathematical stochastics"; • explain basic ideas of proof in the area "Applied and mathematical stochastics"; • illustrate typical applications in the area "Applied and mathematical stochastics".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3141.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Applied and mathematical stochastics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3145: Introduction to statistical modelling and inference**	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Statistical modelling and inference" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the fundamental principles of statistics and inference in parametric and non-parametric models: estimation, testing, confidence statements, prediction, model selection and validation; • are familiar with the tools of asymptotic statistical inference; • learn Bayes and frequentist approaches to data modelling and inference, as well as the interplay between both, in particular empirical Bayes methods; • are able to implement Monte Carlo statistical methods for Bayes and frequentist inference and learn their theoretical properties; • become confident in non-parametric (regression) modelling and inference for various types of the data: count, categorical, dependent, etc.; • are able to develop and mathematically evaluate complex statistical models for real data problems. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Statistical modelling and inference"; • explain basic ideas of proof in the area "Statistical modelling and inference"; • illustrate typical applications in the area "Statistical modelling and inference".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examoral examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3145.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements:	
Proof of knowledge and mastery of basic competencies in the area "Statistical modelling and inference"	

Admission requirements:	**Recommended previous knowledge:**

none	B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3146: Introduction to multivariate statistics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Multivariate statistics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are well acquainted with the most important methods of multivariate statistics like estimation, testing, confidence statements, prediction, linear and generalized linear models, and use them in modeling real world applications; • can apply more specific methods of multivariate statistics such as dimension reduction by principal component analysis (PCA), factor analysis and multidimensional scaling; • are familiar with handling non-Euclidean data such as directional or shape data using parametric and non-parametric models; • are confident using nested descriptors for non-Euclidean data and Procrustes methods in shape analysis; • are familiar with time dependent data, basic functional data analysis and inferential concepts such as kinematic formulae; • analyze basic dependencies between topology/geometry of underlying spaces and asymptotic limiting distributions; • are confident to apply resampling methods to non-Euclidean descriptors; • are familiar with high-dimensional discrimination and classification techniques such as kernel PCA, regularization methods and support vector machines; • have a fundamental knowledge of statistics of point processes and Bayesian methods involved; • are familiar with concepts of large scale computational statistical techniques; • independently become acquainted with a current topic of multivariate and non-Euclidean statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Multivariate statistics"; • explain basic ideas of proof in the area "Multivariate statistics"; • illustrate typical applications in the area "Multivariate statistics".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH

Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3146.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Multivariate statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3147: Introduction to statistical foundations of data science**	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Statistical foundations of data science" enables students to learn methods, concepts, theories and applications in the area of "Statistical foundations of data science". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with the most important methods of statistical foundations of data science like estimation, testing, confidence statements, prediction, resampling, pattern recognition and classification, and use them in modeling real world applications;
- evaluate statistical methods mathematically precisely via suitable statistical risk and loss concepts;
- analyse characteristics of statistical estimation methods via lower and upper information bounds;
- are familiar with basic statistical distribution models that base on the theory of exponential families;
- are confident in modelling real world data structures such as categorial data, multidimensional and high dimensional data, data in imaging, data with serial dependencies
- analyse practical statistical problems in a mathematically accurate way with the techniques and models learned on the one hand and via computer simulations on the other hand;
- are able to mathematically analyse resampling methods and apply them purposively;
- are familiar with concepts of large scale computational statistical techniques;
- are familiar with advanced tools of non-parametric statistics and empirical process theory;
- independently become acquainted with a current topic of statistical data science;
- evaluate complex statistical methods and enhance them in a problem-oriented way.

Core skills:

After having successfully completed the module, students will be able to

- discuss basic concepts of the area "Statistical foundations of data science";
- explain basic ideas of proof in the area "Statistical foundations of data science";
- illustrate typical applications in the area "Statistical foundations of data science".

Workload:
Attendance time:
84 h
Self-study time:
186 h

Course: Lecture course (Lecture)	4 WLH
Examination: written examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3147.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Statistical foundations of data science"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Modul B.Mat.3230: Proseminar "Numerische und Angewandte Mathematik"** *English title: Proseminar on numerical and applied mathematics*	3 C 2 SWS

Lernziele/Kompetenzen:

Lernziele:

Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, Inhalte aus dem Bereich "Numerische und Angewandte Mathematik" vor einem Fachpublikum adäquat darzustellen. Sie

- erwerben selbständig vertiefte Kenntnisse in einem ausgewählten Gebiet der numerischen Mathematik oder der Optimierung;
- strukturieren den Stoff und bereiten ihn für einen Vortrag auf.

Kompetenzen:

Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage,

- sich in ein Thema aus dem Gebiet "Numerische und Angewandte Mathematik", typischerweise aus einem Lehrbuch, selbständig einzuarbeiten und es in einem Vortrag vorzustellen;
- Medien wie Folien, Tafel, Smartboard u.a. zur Präsentation eines mathematischen Themas adäquat einzusetzen.

Arbeitsaufwand:
Präsenzzeit:
28 Stunden
Selbststudium:
62 Stunden

Lehrveranstaltung: Proseminar (2 SWS)	
Prüfung: Präsentation (ca. 75 Minuten, bei Durchführung als Blockseminar ca. 45 Minuten) **Prüfungsvorleistungen:** Teilnahme am Proseminar	3 C

Prüfungsanforderungen:
Selbständige Durchdringung und Darstellung mathematischer Sachverhalte im Fachgebiet "Numerische und Angewandte Mathematik".

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.1300
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.3239: Proseminar im Zyklus "Wissenschaftliches Rechnen / Angewandte Mathematik"** *English title: Proseminar on scientific computing / applied mathematics*	3 C 2 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, Inhalte aus dem Bereich des wissenschaftlichen Rechnens oder der angewandten Mathematik vor einem Fachpublikum adäquat darzustellen. Sie • erwerben selbständig vertiefte Kenntnisse in einem ausgewählten Gebiet des wissenschaftlichen Rechnens oder der angewandten Mathematik; • strukturieren den Stoff und bereiten ihn für einen Vortrag auf. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage • sich in ein Thema aus einem der Gebiete "Wissenschaftliches Rechnen" oder "Angewandte Mathematik", typischerweise aus einem Lehrbuch, selbständig einzuarbeiten und es in einem Vortrag vorzustellen; • Medien wie Folien, Tafel, Smartboard u.a. zur Präsentation eines mathematischen Themas adäquat einzusetzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Proseminar (2 SWS)	
Prüfung: Präsentation (ca. 75 Minuten, bei Durchführung als Blockseminar ca. 45 Minuten) **Prüfungsvorleistungen:** Teilnahme am Proseminar	3 C

Prüfungsanforderungen: Selbständige Durchdringung und Darstellung mathematischer Sachverhalte im Bereich"Wissenschaftliches Rechnen / Angewandte Mathematik".	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.1300
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.3240: Proseminar "Mathematische Stochastik"** *English title: Proseminar on mathematical stochastics*	3 C 2 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, Inhalte aus einem Bereich der mathematischen Stochastik vor einem Fachpublikum adäquat darzustellen. Sie • erwerben selbständig vertiefte Kenntnisse in einem ausgewählten Gebiet der mathematischen Stochastik; • strukturieren den Stoff und bereiten ihn für einen Vortrag auf. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage • sich in ein Thema aus dem Gebiet "Mathematische Stochastik", typischerweise aus einem Lehrbuch, selbständig einzuarbeiten und es in einem Vortrag vorzustellen; • Medien wie Folien, Tafel, Smartboard u.a. zur Präsentation eines mathematischen Themas adäquat einzusetzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Proseminar (2 SWS) (Proseminar)	
Prüfung: Präsentation (ca. 75 Minuten, bei Durchführung als Blockseminar ca. 45 Minuten) **Prüfungsvorleistungen:** Teilnahme am Proseminar	3 C
Prüfungsanforderungen: Selbständige Durchdringung und Darstellung mathematischer Sachverhalte im Fachgebiet "Mathematische Stochastik".	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.1400
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Mathematische Stochastik

Georg-August-Universität Göttingen **Modul B.Mat.3244: Proseminar "Mathematische Statistik"** *English title: Proseminar on mathematical statistics*	3 C 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, Inhalte aus einem Bereich der mathematischen Statistik vor einem Fachpublikum adäquat darzustellen. Sie • erwerben selbständig vertiefte Kenntnisse in einem ausgewählten Gebiet der mathematischen Statistik; • strukturieren den Stoff und bereiten ihn für einen Vortrag auf. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage • sich in ein Thema aus dem Gebiet "Mathematische Statistik", typischerweise aus einem Lehrbuch, selbständig einzuarbeiten und es in einem Vortrag vorzustellen; • Medien wie Folien, Tafel, Smartboard u.a. zur Präsentation eines mathematischen Themas adäquat einzusetzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Proseminar (2 SWS) (Proseminar)	
Prüfung: Präsentation (ca. 75 Minuten, bei Durchführung als Blockseminar ca. 45 Minuten) **Prüfungsvorleistungen:** Teilnahme am Proseminar	3 C

Prüfungsanforderungen: Selbständige Durchdringung und Darstellung mathematischer Sachverhalte im Fachgebiet "Mathematische Statistik".	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.1400
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Mathematische Stochastik

Georg-August-Universität Göttingen **Module B.Mat.3331: Advances in inverse problems**	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Inverse problems" enables students to learn methods, concepts, theories and applications in the area of "Inverse problems". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the phenomenon of illposedness and identify the degree of illposedness of typical inverse problems; • evaluate different regularisation methods for ill posed inverse problems under algorithmic aspects and with regard to various a priori information and distinguish concepts of convergence for such methods with deterministic and stochastic data errors; • analyse the convergence of regularisation methods with the help of spectral theory of bounded self-adjoint operators; • analyse the convergence of regularisation methods with the help of complex analysis; • analyse regularisation methods from stochastic error models; • apply fully data-driven models for the choice of regularisation parameters and evaluate these for concrete problems; • model identification problems in natural sciences and technology as inverse problems of partial differential equations where the unknown is e. g. a coefficient, an initial or a boundary condition or the shape of a region; • analyse the uniqueness and conditional stability of inverse problems of partial differential equations; • deduce sampling and testing methods for the solution of inverse problems of partial differential equations and analyse the convergence of such methods; • formulate mathematical models of medical imaging like computer tomography (CT) or magnetic resonance tomography (MRT) and know the basic characteristics of corresponding operators. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Inverse problems" confidently; • explain complex issues of the area "Inverse problems"; • apply methods of the area "Inverse problems" to new problems in this area.	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3331.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Inverse problems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3131
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3131 "Introduction to inverse problems"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3334: Advances in optimisation	9 C 6 WLH

Learning outcome, core skills:	Workload:
Learning outcome: The successful completion of modules of the cycle "Optimisation" enables students to learn methods, concepts, theories and applications in the area of "Optimisation", so the discrete and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • identify optimisation problems in application-oriented problems and formulate these as mathematical programmes; • evaluate the existence and uniqueness of the solution of an optimisation problem; • identify structural characteristics of an optimisation problem, amongst others the existence of a finite candidate set, the structure of the underlying level set; • know which special characteristics of the target function and the constraints (like (virtual) convexity, dc functions) for the development of solution strategies can be utilised; • analyse the complexity of an optimisation problem; • classify a mathematical programme in a class of optimisation problems and know current solution strategies for it; • develop optimisation methods and adapt general methods to special problems; • deduce upper and lower bounds for optimisation problems and understand their meaning; • understand the geometrical structure of an optimisation problem and apply it for solution strategies; • distinguish between proper solution methods, approximation methods with quality guarantee and heuristics and evaluate different methods on the basis of the quality of the found solutions and their computing times; • acquire advanced knowledge in the development of solution strategies on the basis of a special area of optimisation, e. g. integer optimisation, optimisation of networks or convex optimisation; • acquire advanced knowledge for the solution of special optimisation problems of an application-oriented area, e. g. traffic planning or location planning; • handle advanced optimisation problems, like e. g. optimisation problems with uncertainty or multi-criteria optimisation problems. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Optimisation" confidently; • explain complex issues of the area "Optimisation"; • apply methods of the area "Optimisation" to new problems in this area.	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3334.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Optimisation"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3134
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3134 "Introduction to optimisation"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: Instructor: Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3337: Advances in variational analysis	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Variational analysis" enables students to learn methods, concepts, theories and applications in the area of "Variational analysis" and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • understand basic concepts of convex and variational analysis for finite- and infinite-dimensional problems; • master the characteristics of convexity and other concepts of the regularity of sets and functions to evaluate the existence and regularity of the solutions of variational problems; • understand basic concepts of the convergence of sets and continuity of set-valued functions; • understand basic concepts of variational geometry; • calculate and use generalised derivations (subderivatives and subgradients) of non-smooth functions; • understand the different concepts of regularity of set-valued functions and their effects on the calculation rules for subderivatives of non-convex functionals; • analyse constrained and parametric optimisation problems with the help of duality theory; • calculate and use the Legendre-Fenchel transformation and infimal convulutions; • formulate optimality criteria for continuous optimisation problems with tools of convex and variational analysis; • apply tools of convex and variational analysis to solve generalised inclusions that e. g. originate from first-order optimality criteria; • understand the connection between convex functions and monotone operators; • examine the convergence of fixed point iterations with the help of the theory of monotone operators; • deduce methods for the solution of smooth and non-smooth continuous constrained optimisation problems and analyse their convergence; • apply numerical methods for the solution of smooth and non-smooth continuous constrained programs to current problems; • model application problems with variational inequations, analyse their characteristics and are familiar with numerical methods for the solution of variational inequations; • know applications of control theory and apply methods of dynamic programming; • use tools of variational analysis in image processing and with inverse problems; • know basic concepts and methods of stochastic optimisation. **Core skills:**	**Workload:** Attendance time: 84 h Self-study time: 186 h

After having successfully completed the module, students will be able to • handle methods and concepts of the area "Variational analysis" confidently; • explain complex issues of the area "Variational analysis"; • apply methods of the area "Variational analysis" to new problems in this area.	

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3337.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Variational analysis"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3137
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3137 "Introduction in variational analysis"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3338: Advances in image and geometry processing	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Image and geometry processing" enables students to learn and apply methods, concepts, theories and applications in the area of "Image and geometry processing", so the digital image and geometry processing. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of problems of image and geometry processing in suitable finite- and infinite-dimensional vector spaces; • learn basic methods for the analysis of one- and multidimensional functions in Banach and Hilbert spaces; • learn basic mathematical concepts and methods that are used in image processing, like Fourier and Wavelet transform; • learn basic mathematical concepts and methods that play a central role in geometry processing, like curvature of curves and surfaces; • acquire knowledge about continuous and discrete problems of image data analysis and their corresponding solution strategies; • know basic concepts and methods of topology; • are familiar with visualisation software; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • know which special characteristics of an image or of a geometry can be extracted and worked on with which methods; • evaluate different numerical methods for the efficient analysis of multidimensional data on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear methods for the geometrical and topological analysis of multidimensional data; • are informed about current developments of efficient geometrical and topological data analysis; • adapt solution strategies for the data analysis using special structural characteristics of the given multidimensional data. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Image and geometry processing" confidently; • explain complex issues of the area "Image and geometry processing";	**Workload:** Attendance time: 84 h Self-study time: 186 h

• apply methods of the area "Image and geometry processing" to new problems in this area.	

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3338.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Image and geometry processing"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3138
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3138 "Introduction to image and geometry processing"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module B.Mat.3339: Advances in scientific computing / applied mathematics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Scientific computing / Applied mathematics" enables students to learn and apply methods, concepts, theories and applications in the area of "Scientific computing / Applied mathematics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of basic mathematical models of the corresponding subject area, especially about the existence and uniqueness of solutions; • know basic methods for the numerical solution of these models; • analyse stability, convergence and efficiency of numerical solution strategies; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • are informed about current developments of scientific computing, like e. g. GPU computing and use available soft- and hardware; • use methods of scientific computing for solving application problems, like e. g. of natural and business sciences. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Scientific computing / applied mathematics" confidently; • explain complex issues of the area "Scientific computing / applied mathematics"; • apply methods of the area "Scientific computing / applied mathematics" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3339.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Scientific computing / applied mathematics"	

Admission requirements: none	Recommended previous knowledge: B.Mat.3139
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3139 "Introduction to scientific computing / applied mathematics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations:
Instructor: Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module B.Mat.3341: Advances in applied and mathematical stochastics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Applied and mathematical stochastics" enables students to understand and apply a broad range of problems, theories, modelling and proof techniques of stochastics. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued: Students • are familiar with advanced concepts of probability theory established on measure theory and apply them independently; • are familiar with substantial concepts and approaches of probability modelling and inferential statistics; • know basic characteristics of stochastic processes as well as conditions for their existence and uniqueness; • have a pool of different stochastic processes in time and space at their disposal and characterise those, differentiate them and quote examples; • understand and identify basic characteristics of invariance of stochastic processes like stationary processes and isotropy; • analyse the convergence characteristic of stochastic processes; • analyse regularity characteristics of the paths of stochastic processes; • adequately model temporal and spatial phenomena in natural and economic sciences as stochastic processes, if necessary with unknown parameters; • analyse probabilistic and statistic models regarding their typical characteristics, estimate unknown parameters and make predictions for their paths on areas not observed / at times not observed; • discuss and compare different modelling approaches and evaluate the reliability of parameter estimates and predictions sceptically. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Applied and mathematical stochastics" confidently; • explain complex issues of the area "Applied and mathematical stochastics"; • apply methods of the area "Applied and mathematical stochastics" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3341.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Applied and mathematical stochastics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3141
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3141 "Introduction to applied and mathematical stochastics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module B.Mat.3345: Advances in statistical modelling and inference	9 C 6 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Statistical modelling and inference" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the fundamental principles of statistics and inference in parametric and non-parametric models: estimation, testing, confidence statements, prediction, model selection and validation; • are familiar with the tools of asymptotic statistical inference; • learn Bayes and frequentist approaches to data modelling and inference, as well as the interplay between both, in particular empirical Bayes methods; • are able to implement Monte Carlo statistical methods for Bayes and frequentist inference and learn their theoretical properties; • become confident in non-parametric (regression) modelling and inference for various types of the data: count, categorical, dependent, etc.; • are able to develop and mathematically evaluate complex statistical models for real data problems. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Statistical modelling and inference" confidently; • explain complex issues of the area "Statistical modelling and inference"; • apply methods of the area "Statistical modelling and inference" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3345.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Statistical modelling and inference"	

Admission requirements:	**Recommended previous knowledge:**

none	B.Mat.3145
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3111 "Introduction to statistical modelling and inference"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module B.Mat.3346: Advances in multivariate statistics	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Multivariate statistics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are well acquainted with the most important methods of multivariate statistics like estimation, testing, confidence statements, prediction, linear and generalized linear models, and use them in modeling real world applications;
- can apply more specific methods of multivariate statistics such as dimension reduction by principal component analysis (PCA), factor analysis and multidimensional scaling;
- are familiar with handling non-Euclidean data such as directional or shape data using parametric and non-parametric models;
- are confident using nested descriptors for non-Euclidean data and Procrustes methods in shape analysis;
- are familiar with time dependent data, basic functional data analysis and inferential concepts such as kinematic formulae;
- analyze basic dependencies between topology/geometry of underlying spaces and asymptotic limiting distributions;
- are confident to apply resampling methods to non-Euclidean descriptors;
- are familiar with high-dimensional discrimination and classification techniques such as kernel PCA, regularization methods and support vector machines;
- have a fundamental knowledge of statistics of point processes and Bayesian methods involved;
- are familiar with concepts of large scale computational statistical techniques;
- independently become acquainted with a current topic of multivariate and non-Euclidean statistics;
- evaluate complex statistical methods and enhance them in a problem-oriented way.

Core skills:

After having successfully completed the module, students will be able to

- handle methods and concepts of the area "Multivariate statistics" confidently;
- explain complex issues of the area "Multivariate statistics";
- apply methods of the area "Multivariate statistics" to new problems in this area.

Workload:

Attendance time:
84 h

Self-study time:
186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes)	9 C

Examination prerequisites: B.Mat.3346.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Multivariate statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3146
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3146 "Introduction to multivariate statistics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3347: Advances in statistical foundations of data science**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle ""Statistical foundations of data science" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of statistical foundations of data science like estimation, testing, confidence statements, prediction, resampling, pattern recognition and classification, and use them in modeling real world applications; • evaluate statistical methods mathematically precisely via suitable statistical risk and loss concepts; • analyse characteristics of statistical estimation methods via lower and upper information bounds; • are familiar with basic statistical distribution models that base on the theory of exponential families; • are confident in modelling real world data structures such as categorial data, multidimensional and high dimensional data, data in imaging, data with serial dependencies • analyse practical statistical problems in a mathematically accurate way with the techniques and models learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with concepts of large scale computational statistical techniques; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of statistical data science; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area ""Statistical foundations of data science" confidently; • explain complex issues of the area ""Statistical foundations of data sciencee"; • apply methods of the area ""Statistical foundations of data science" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3347.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Statistical foundations of data science"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3147
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3147 "Introduction to statistical foundations of data science"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Modul B.Mat.3431: Seminar im Zyklus "Inverse Probleme"** *English title: Seminar on inverse problems*	3 C 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Das erfolgreiche Absolvieren von Modulen zum Zyklus "Inverse Probleme" ermöglicht den Studierenden, Methoden, Begriffe, Theorien und Anwendungen im Bereich "Inverse Probleme" kennenzulernen. Sie werden sukzessive an aktuelle Forschungsthemen herangeführt und befähigt, in diesem Bereich erste eigene Beiträge zur Forschung zu leisten (z.B. im Rahmen einer Masterarbeit). Je nach aktuellem Lehrangebot unterschiedlich geordnet und gewichtet werden folgende inhaltsbezogene Kompetenzen angestrebt. Die Studierenden • sind mit dem Phänomen der Schlechtgestelltheit vertraut und erkennen den Grad der Schlechtgestelltheit von typischen inversen Problemen; • bewerten verschiedene Regularisierungsverfahren für schlecht gestellte inverse Probleme unter algorithmischen Aspekten und im Hinblick auf verschiedenartige apriori-Informationen und unterscheiden Konvergenzbegriffe für solche Verfahren bei deterministischen und stochastischen Datenfehlern; • analysieren die Konvergenz von Regularisierungsverfahren mit Hilfe der Spektraltheorie beschränkter, selbstadjungierter Operatoren; • analysieren die Konvergenz von Regularisierungsverfahren mit Methoden der konvexen Analysis; • analysieren Regularisierungsverfahren unter stochastischen Fehlermodellen; • wenden vollständig datengesteuerte Methoden zur Wahl von Regularisierungsparametern an und bewerten sie für konkrete Probleme; • modellieren Identifikationsprobleme in Naturwissenschaften und Technik als inverse Probleme bei partiellen Differenzialgleichungen, bei denen die Unbekannte z.B. ein Koeffizient, eine Anfangs- oder Randbedingung oder die Form eines Gebiets ist; • analysieren die Eindeutigkeit und konditionale Stabilität von inversen Problemen bei partiellen Differenzialgleichungen; • leiten Sampling- und Probe-Methoden zur Lösung inverser Probleme bei partiellen Differenzialgleichungen her und analysieren die Konvergenz solcher Methoden; • entwerfen mathematische Modelle von medizinischen Bildgebungsverfahren wie Computer-Tomographie (CT) oder Magnetresonanztomographie (MRT) und kennen grundlegende Eigenschaften entsprechender Operatoren. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • sich in ein mathematisches Thema im Bereich "Inverse Probleme" einzuarbeiten und in einem Vortrag vorzustellen; • wissenschaftliche Diskussionen in einem bekannten Kontext zu führen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Seminar (2 SWS) (Seminar)	

Prüfung: Präsentation (ca. 75 Minuten, bei Durchführung als Blockseminar ca. 45 Minuten) **Prüfungsvorleistungen:** Teilnahme am Seminar	3 C

Prüfungsanforderungen: Selbständige Durchdringung und Darstellung komplexer mathematischer Sachverhalte im Bereich "Inverse Probleme"	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.3131
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.3434: Seminar im Zyklus "Optimierung"** *English title: Seminar on optimisation*	3 C 2 SWS

Lernziele/Kompetenzen:

Lernziele:

Das erfolgreiche Absolvieren von Modulen zum Zyklus "Optimierung" ermöglicht den Studierenden, Methoden, Begriffe, Theorien und Anwendungen im Bereich "Optimierung", also der diskreten und kontinuierlichen Optimierung, kennenzulernen. Sie werden sukzessive an aktuelle Forschungsthemen herangeführt und befähigt, in diesem Bereich erste eigene Beiträge zur Forschung zu leisten (z.B. im Rahmen eines Praktikums im wissenschaftlichen Rechnen oder einer Masterarbeit). Je nach aktuellem Lehrangebot unterschiedlich geordnet und gewichtet werden folgende inhaltsbezogene Kompetenzen angestrebt. Die Studierenden

- erkennen Optimierungsprobleme in anwendungsorientierten Fragestellungen und formulieren sie als mathematische Programme;
- beurteilen Existenz und Eindeutigkeit der Lösung eines Optimierungsproblemes;
- erkennen strukturelle Eigenschaften eines Optimierungsproblemes, u.a. die Existenz einer endlichen Kandidatenmenge, die Struktur der zugrunde liegenden Niveaumengen;
- wissen, welche speziellen Eigenschaften der Zielfunktion und der Nebenbedingungen (wie (quasi-)Konvexität, dc-Funktionen) bei der Entwicklung von Lösungsverfahren ausgenutzt werden können;
- analysieren die Komplexität eines Optimierungsproblemes;
- ordnen ein mathematisches Programm in eine Klasse von Optimierungsproblemen ein und kennen dafür die gängigen Lösungsverfahren;
- entwickeln Optimierungsverfahren und passen allgemeine Verfahren auf spezielle Probleme an;
- leiten obere und untere Schranken an Optimierungsprobleme her und verstehen ihre Bedeutung;
- verstehen die geometrische Struktur eines Optimierungsproblemes und machen sie sich bei Lösungsverfahren zunutze;
- unterscheiden zwischen exakten Lösungsverfahren, Approximationsverfahren mit Gütegarantie und Heuristiken und bewerten verschiedene Verfahren anhand der Qualität der aufgefundenen Lösungen und ihrer Rechenzeit;
- erwerben vertiefte Kenntnisse in der Entwicklung von Lösungsverfahren anhand eines speziellen Bereiches der Optimierung, z.B. der ganzzahligen Optimierung, der Optimierung auf Netzwerken oder der konvexen Optimierung;
- erwerben vertiefte Kenntnisse bei der Lösung von speziellen Optimierungsproblemen aus einem anwendungsorientierten Bereich, z.B. der Verkehrsplanung oder der Standortplanung;
- gehen mit erweiterten Optimierungsproblemen um, wie z.B. Optimierungsproblemen unter Unsicherheit oder multikriteriellen Optimierungsproblemen.

Arbeitsaufwand:
Präsenzzeit:
28 Stunden
Selbststudium:
62 Stunden

Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • sich in ein mathematisches Thema im Bereich "Optimierung" im Bereich "Optimierung" einzuarbeiten und in einem Vortrag vorzustellen; • wissenschaftliche Diskussionen in einem bekannten Kontext zu führen.	

Lehrveranstaltung: Seminar (2 SWS) (Seminar)	
Prüfung: Präsentation (ca. 75 Minuten, bei Durchführung als Blockseminar ca. 45 Minuten) **Prüfungsvorleistungen:** Teilnahme am Seminar	3 C

Prüfungsanforderungen: Selbständige Durchdringung und Darstellung komplexer mathematischer Sachverhalte im Bereich "Optimierung"	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.3134
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.3437: Seminar im Zyklus "Variationelle Analysis"** *English title: Seminar on variational analysis*	3 C 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Das erfolgreiche Absolvieren von Modulen zum Zyklus "Variationelle Analysis" ermöglicht den Studierenden, Methoden, Begriffe, Theorien und Anwendungen in variationeller Analysis und kontinuierlicher Optimierung kennenzulernen. Sie werden sukzessive an aktuelle Forschungsthemen herangeführt und befähigt, in diesem Bereich erste eigene Beiträge zur Forschung zu leisten (z.B. im Rahmen eines Praktikums im wissenschaftlichen Rechnen oder einer Masterarbeit). Je nach aktuellem Lehrangebot unterschiedlich geordnet und gewichtet werden folgende inhaltsbezogene Kompetenzen angestrebt. Die Studierenden • verstehen fundamentale Begriffe der konvexen und variationellen Analysis für endlich- und unendlich-dimensionale Probleme; • beherrschen die Eigenschaften von Konvexität und anderen Begriffen der Regularität von Mengen und Funktionen, um Existenz und Regularität der Lösungen variationeller Probleme zu beurteilen; • verstehen fundamentale Begriffe der Konvergenz von Mengen und Stetigkeit mengenwertiger Funktionen; • verstehen fundamentale Begriffe der variationellen Geometrie; • berechnen und verwenden verallgemeinerte Ableitungen (Subdifferenziale und Subgradienten) nicht-glatter Funktionen; • verstehen die verschiedenen Konzepte von Regularität mengenwertiger Funktionen und ihre Auswirkungen auf die Rechenregeln für Subdifferenziale nichtkonvexer Funktionale; • analysieren mit Hilfe der Dualitätstheorie restringierte und parametrische Optimierungsprobleme; • berechnen und verwenden die Fenchel-Legendre Transformation und infimale Entfaltungen; • formulieren Optimalitätskriterien für kontinuierliche Optimierungsprobleme mit Werkzeugen der konvexen und variationellen Analysis; • wenden Werkzeuge der konvexen und variationellen Analysis an, um verallgemeinerte Inklusionen zu lösen, die zum Beispiel aus Optimalitätskriterien erster Ordnung entstanden sind; • verstehen die Verbindung zwischen konvexen Funktionen und monotonen Operatoren; • untersuchen die Konvergenz von Fixpunktiterationen mit Hilfe der Theorie monotoner Operatoren; • leiten Verfahren zur Lösung glatter und nichtglatter kontinuierlicher, restringierter Optimierungsprobleme her und analysieren deren Konvergenz; • wenden numerische Verfahren zur Lösung glatter und nichtglatter kontinuierlicher, restringierter Programme auf aktuelle Probleme an;	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

• modellieren Anwendungsprobleme durch Variationsungleichungen, analysieren deren Eigenschaften und sind mit numerischen Verfahren zur Lösung von Variationsungleichungen vertraut; • kennen Anwendungen in der Kontrolltheorie und wenden Methoden der dynamischen Programmierung an; • benutzen Werkzeuge der variationellen Analysis in der Bildverarbeitung und bei Inversen Problemen; • kennen Grundbegriffe und Methoden der stochastischen Optimierung. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • sich in ein mathematisches Thema im Bereich "Variationelle Analysis" einzuarbeiten und in einem Vortrag vorzustellen; • wissenschaftliche Diskussionen in einem bekannten Kontext zu führen.	

Lehrveranstaltung: Seminar (2 SWS) (Seminar)	
Prüfung: Präsentation (ca. 75 Minuten, bei Durchführung als Blockseminar ca. 45 Minuten) **Prüfungsvorleistungen:** Teilnahme am Seminar	3 C

Prüfungsanforderungen: Selbständige Durchdringung und Darstellung komplexer mathematischer Sachverhalte im Bereich "Variationelle Analysis"	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.3137
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.3438: Seminar im Zyklus "Bild- und Geometrieverarbeitung"** *English title: Seminar on image and geometry processing*	3 C 2 SWS
Lernziele/Kompetenzen: **Lernziele:** Das erfolgreiche Absolvieren von Modulen zum Zyklus "Bild- und Geometrieverarbeitung" ermöglicht den Studierenden, Methoden, Begriffe, Theorien und Anwendungen im Bereich "Bild- und Geometrieverarbeitung", also der digitalen Bild- und Geometrieverarbeitung, kennenzulernen und anzuwenden. Sie werden sukzessive an aktuelle Forschungsthemen herangeführt und befähigt, in diesem Bereich erste eigene Beiträge zur Forschung zu leisten (z.B. im Rahmen eines Praktikums im wissenschaftlichen Rechnen oder einer Masterarbeit). Je nach aktuellem Lehrangebot unterschiedlich geordnet und gewichtet werden folgende inhaltsbezogene Kompetenzen angestrebt. Die Studierenden • sind mit der Modellierung von Problemen der Bild- und Geometrieverarbeitung in geeigneten endlich- und unendlich-dimensionalen Vektorräumen vertraut; • erlernen grundlegende Methoden zur Analyse von ein- und mehrdimensionalen Funktionen in Banach- und Hilberträumen; • erlernen grundlegende mathematische Begriffe und Methoden, die in der Bildverarbeitung verwendet werden, wie Fourier- und Wavelettransformationen; • erlernen grundlegende mathematische Begriffe und Methoden, die in der Geometrieverarbeitung eine zentrale Rolle spielen, wie Krümmung von Kurven und Flächen; • erwerben Kenntnisse zu kontinuierlichen und zu diskreten Problemen der Bilddatenanalyse und den zugehörigen Lösungsstrategien; • kennen grundlegende Begriffe und Methoden der Topologie; • sind mit Visualisierungs-Software vertraut; • wenden verfügbare Software zur Lösung der zugehörigen numerischen Verfahren an und bewerten die Ergebnisse kritisch; • wissen, welche speziellen Eigenschaften eines Bildes oder einer Geometrie mit welchen Methoden extrahiert und bearbeitet werden können; • bewerten verschiedene numerische Verfahren zur effizienten Analyse mehrdimensionaler Daten anhand der Qualität der Lösungen, der Komplexität und der Rechenzeit; • erwerben vertiefte Kenntnisse zu linearen und nichtlinearen Verfahren zur geometrischen und topologischen Analyse mehrdimensionaler Daten; • sind über aktuelle Entwicklungen zur effizienten geometrischen und topologischen Datenanalyse informiert; • adaptieren Lösungsstrategien zur Datenanalyse unter Ausnutzung spezieller struktureller Eigenschaften der gegebenen mehrdimensionalen Daten. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage,	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

• sich in ein mathematisches Thema im Bereich "Bild- und Geometrieverarbeitung" einzuarbeiten und in einem Vortrag vorzustellen; • wissenschaftliche Diskussionen in einem bekannten Kontext zu führen.	
Lehrveranstaltung: Seminar (2 SWS) (Seminar)	
Prüfung: Präsentation (ca. 75 Minuten, bei Durchführung als Blockseminar ca. 45 Minuten) **Prüfungsvorleistungen:** Teilnahme am Seminar	3 C
Prüfungsanforderungen: Selbständige Durchdringung und Darstellung komplexer mathematischer Sachverhalte im Bereich "Bild- und Geometrieverarbeitung"	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.3138
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.3439: Seminar im Zyklus "Wissenschaftliches Rechnen / Angewandte Mathematik"** *English title: Seminar on scientific computing / applied mathematics*	3 C 2 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele: Das erfolgreiche Absolvieren von Modulen zum Zyklus "Wissenschaftliches Rechnen/ Angewandte Mathematik" ermöglicht den Studierenden, Methoden, Begriffe, Theorien und Anwendungen im Bereich "Wissenschaftliches Rechnen/Angewandte Mathematik" kennenzulernen. Sie werden sukzessive an aktuelle Forschungsthemen herangeführt und befähigt, in diesem Bereich erste eigene Beiträge zur Forschung zu leisten (z.B. im Rahmen eines Praktikums im wissenschaftlichen Rechnen oder einer Masterarbeit). Je nach aktuellem Lehrangebot unterschiedlich geordnet und gewichtet werden folgende inhaltsbezogene Kompetenzen angestrebt. Die Studierenden • sind mit der Theorie der grundlegenden mathematischen Modelle des jeweiligen Lehrgebietes, insbesondere zu Existenz und Eindeutigkeit von Lösungen, vertraut; • kennen grundlegende Methoden zur numerischen Lösung dieser Modelle; • analysieren Stabilität, Konvergenz und Effizienz numerischer Lösungsverfahren; • wenden verfügbare Software zur Lösung der betreffenden numerischen Verfahren an und bewerten die Ergebnisse kritisch; • bewerten verschiedene numerische Verfahren anhand der Qualität der Lösungen, der Komplexität und ihrer Rechenzeit; • sind über aktuelle Entwicklungen des wissenschaftlichen Rechnens, wie zum Beispiel GPU-Computing, informiert und wenden vorhandene Soft- und Hardware an; • setzen Methoden des wissenschaftlichen Rechnens zum Lösen von Anwendungsproblemen, z.B. aus Natur- und Wirtschaftswissenschaften, ein. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • sich in ein mathematisches Thema im Bereich"Wissenschaftliches Rechnen / Angewandte Mathematik" einzuarbeiten und in einem Vortrag vorzustellen; • wissenschaftliche Diskussionen in einem bekannten Kontext zu führen.	Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Seminar (2 SWS) (Seminar)	
Prüfung: (ca. 75 Minuten, bei Durchführung als Blockseminar ca. 45 Minuten) **Prüfungsvorleistungen:** Teilnahme am Seminar	3 C

Prüfungsanforderungen: Selbständige Durchdringung und Darstellung komplexer mathematischer Sachverhalte im Bereich"Wissenschaftliches Rechnen / Angewandte Mathematik"	

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**

keine	B.Mat.3139
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.3441: Seminar im Zyklus "Angewandte und Mathematische Stochastik"** *English title: Seminar on applied and mathematical stochastics*	3 C 2 SWS

Lernziele/Kompetenzen:

Lernziele:

Das erfolgreiche Absolvieren von Modulen zum Zyklus "Angewandte und Mathematische Stochastik" ermöglicht es den Studierenden, eine breite Auswahl von Fragestellungen, Theorien, Modellierungs- und Beweistechniken aus der Stochastik zu verstehen und anzuwenden. Von grundlegender Wichtigkeit sind dabei stochastische Prozesse in Zeit und Raum und deren Anwendungen in der Modellierung und Statistik. Im Laufe des Zyklus werden die Studierenden sukzessive an aktuelle Forschungsthemen herangeführt und befähigt, in diesem Bereich erste eigene Beiträge zur Forschung zu leisten (z.B. im Rahmen einer Masterarbeit). Je nach aktuellem Lehrangebot unterschiedlich geordnet und gewichtet werden folgende inhaltsbezogene Ziele angestrebt: Die Studierenden

- sind mit weiterführenden Konzepten der maßtheoretisch fundierten Wahrscheinlichkeitstheorie vertraut und wenden diese selbstständig an;
- sind mit wesentlichen Begriffen und Vorgehensweisen der Wahrscheinlichkeitsmodellierung und der schließenden Statistik vertraut;
- kennen grundlegende Eigenschaften stochastischer Prozesse, sowie Bedingungen für deren Existenz und Eindeutigkeit;
- verfügen über einen Fundus von verschiedenen stochastischen Prozessen in Zeit und Raum und charakterisieren diese, grenzen sie gegeneinander ab und führen Beispiele an;
- verstehen und erkennen grundlegende Invarianzeigenschaften stochastischer Prozesse, wie Stationarität und Isotropie;
- analysieren das Konvergenzverhalten stochastischer Prozesse;
- analysieren Regularitätseigenschaften der Pfade stochastischer Prozesse;
- modellieren adäquat zeitliche und räumliche Phänomene in Natur- und Wirtschaftswissenschaften als stochastische Prozesse, gegebenenfalls mit unbekannten Parametern;
- analysieren probabilistische und statistische Modelle hinsichtlich ihres typischen Verhaltens, schätzen unbekannte Parameter und treffen Vorhersagen ihrer Pfade auf nicht beobachteten Gebieten / zu nicht beobachteten Zeiten;
- diskutieren und vergleichen verschiedene Modellierungsansätze und beurteilen die Verlässlichkeit von Parameterschätzungen und Vorhersagen kritisch.

Kompetenzen:

Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage,

- sich in ein mathematisches Thema im Bereich "Angewandte und Mathematische Stochastik" einzuarbeiten und in einem Vortrag vorzustellen;
- wissenschaftliche Diskussionen in einem bekannten Kontext zu führen.

Arbeitsaufwand:

Präsenzzeit:
28 Stunden

Selbststudium:
62 Stunden

Lehrveranstaltung: Seminar (2 SWS) (Seminar)	
Prüfung: Präsentation (ca. 75 Minuten) **Prüfungsvorleistungen:** Teilnahme am Seminar	3 C

Prüfungsanforderungen: Selbständige Durchdringung und Darstellung komplexer mathematischer Sachverhalte im Bereich "Angewandte und Mathematische Stochastik"	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.3141
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Mathematische Stochastik

Georg-August-Universität Göttingen **Modul B.Mat.3445: Seminar im Zyklus "Statistische Modellierung und Inferenz"** *English title: Seminar on statistical modelling and inference*	3 C 2 SWS

Lernziele/Kompetenzen:

Lernziele:

Das erfolgreiche Absolvieren von Modulen zum Zyklus "Statistische Modellierung und Inferenz" ermöglicht den Studierenden Methoden, Begriffe, Theorien und Anwendungen in diesem Bereich kennenzulernen. Sie werden sukzessive an aktuelle Forschungsthemen herangeführt und befähigt, in diesem Bereich erste eigene Beiträge zur Forschung zu leisten (z.B. im Rahmen einer Masterarbeit). Je nach aktuellem Lehrangebot unterschiedlich geordnet und gewichtet werden folgende inhaltsbezogene Kompetenzen angestrebt. Die Studierenden

- sind mit den Grundprizipien der parametrischen und nicht-parametrischen Modellierung in Statistik und Inferenz vertraut: Schätzung, Test, Konfidenzaussagen, Vorhersage, Modellauswahl und Validierung;
- sind mit den Werkzeugen der asymptotischen statistischen Inferenz vertraut;
- Kennen die Bayesianischen und frequentistischen Konzepte zur Datenmodellierung und Inferenz sowie deren Zusammenhang, insbesodere empirische Bayesianische Methoden;
- können statistische Monte Carlo Methoden für Bayesianische und frequentistische Inferenz implementieren und lernen deren theoretische Eigenschaften kennen;
- beherrschen nicht-parametrische (Regressions-)Modelle und Inferenz für verschiedene Datentypen: Zähldaten, kategorielle und abhängige Daten;
- können komplexe statistische Modelle für reale Datenprobleme entwickeln und auswerten.

Kompetenzen:

Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage,

- sich in ein mathematisches Thema im Bereich "Statistische Modellierung und Inferenz" einzuarbeiten und in einem Vortrag vorzustellen;
- wissenschaftliche Diskussionen in einem bekannten Kontext zu führen.

Arbeitsaufwand:
Präsenzzeit:
28 Stunden
Selbststudium:
62 Stunden

Lehrveranstaltung: Seminar (2 SWS) (Seminar)	
Prüfung: Präsentation (ca. 75 Minuten) **Prüfungsvorleistungen:** Teilnahme am Seminar	3 C
Prüfungsanforderungen: Selbständige Durchdringung und Darstellung komplexer mathematischer Sachverhalte im Bereich "Statistische Modellierung und Inferenz"	

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	B.Mat.3145

Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Mathematische Stochastik

Georg-August-Universität Göttingen **Modul B.Mat.3446: Seminar im Zyklus "Multivariate Statistik"** *English title: Seminar on multivariate statistics*	3 C 2 SWS

Lernziele/Kompetenzen:

Lernziele:

Das erfolgreiche Absolvieren von Modulen zum Zyklus "Multivariate Statistik" ermöglicht den Studierenden Methoden, Begriffe, Theorien und Anwendungen in diesem Bereich kennenzulernen. Sie werden nach und nach an aktuelle Forschungsthemen herangeführt und befähigt, in diesem Bereich erste eigene Beiträge zur Forschung zu leisten (z.B. im Rahmen einer Masterarbeit). Je nach aktuellem Lehrangebot, ggf. unterschiedlich geordnet und gewichtet, werden folgende inhaltsbezogene Kompetenzen angestrebt. Die Studierenden

- sind mit den wichtigsten Methoden der multivariaten Statistik wie Schätzung, Test, Konfidenzaussage, Vorhersage, lineare und verallgemeinerte lineare Modelle vertraut und setzen diese in der Modellierung realer Anwendungen ein;
- können spezifische Methoden der multivariaten Statistik wie Dimensionsreduzierung PCA (principal component analysis), Faktoranalysis und multidimensionale Skalierung anwenden;
- sind mit dem Umgang mit nicht-euklidischen Daten wie "Directional analysis" oder "Shape data" vertraut und setzen dafür parametrische und nicht-parametrische Methoden ein;
- können verschachtelte Deskriptoren für nicht-Euklidische Daten verwenden und beherrschen Procrustes-Methoden in der "Shape analysis";
- sind mit zeitabhängigen Daten, Grundlagen der "Functional data analysis" und inferentiellen Konzepten wie kinematischen Formeln vertraut;
- analysieren wesentliche Abhängigkeiten zwischen Topologie/Geometrie der zu Grunde liegenden Abhängigkeiten und Grenzverteilungen;
- wenden Resampling-Methoden sicher auf nicht-euklidische Deskriptoren an;
- beherrschen hoch-dimensionale Diskriminierungs- und Klassifizierungstechniken wie Kern-PCA, Regularisierungsmethoden und "support vector maschines";
- erwerben grundlegendes Wissen über statistische Punktprozesse und der zugehörigen Bayesianischen Methoden;
- beherrschen Techniken der "large scale computational statistics";
- erarbeiten selbstständig aktuelle Themen der multivariaten und nicht-euklidischen Statistik;
- evaluieren komplexe statistische Methoden und entwickeln diese für die Anwendung auf reale Probleme weiter.

Kompetenzen:

Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage,

- sich in ein mathematisches Thema im Bereich "Multivariate Statistik" einzuarbeiten und in einem Vortrag vorzustellen;
- wissenschaftliche Diskussionen in einem bekannten Kontext zu führen.

Arbeitsaufwand:
Präsenzzeit:
28 Stunden
Selbststudium:
62 Stunden

Lehrveranstaltung: Seminar (2 SWS) (Seminar)	
Prüfung: Präsentation (ca. 75 Minuten) **Prüfungsvorleistungen:** Teilnahme am Seminar	3 C

Prüfungsanforderungen: Selbständige Durchdringung und Darstellung komplexer mathematischer Sachverhalte im Bereich "Multivariate Statistik"	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.3146
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Mathematische Stochastik

Georg-August-Universität Göttingen **Modul B.Mat.3447: Seminar im Zyklus "Statistische Grundlagen der Data Science"** *English title: Seminar on statistical foundations of data science*	3 C 2 SWS

Lernziele/Kompetenzen:

Lernziele:

Das erfolgreiche Absolvieren von Modulen zum Zyklus "Statistische Grundlagen der Data Science" ermöglicht den Studierenden Methoden, Begriffe, Theorien und Anwendungen in diesem Bereich kennenzulernen. Sie werden nach und nach an aktuelle Forschungsthemen herangeführt und befähigt, in diesem Bereich erste eigene Beiträge zur Forschung zu leisten (z.B. im Rahmen einer Masterarbeit). Je nach aktuellem Lehrangebot, ggf. unterschiedlich geordnet und gewichtet, werden folgende inhaltsbezogene Kompetenzen angestrebt. Die Studierenden

- sind mit den wichtigsten Methoden der statistischen Grundlagen der Data science wie Schätzung, Test, Konfidenzaussage, Vorhersage, Resampling, Mustererkennung und -klassifizierung vertraut und setzen diese in der Modellierung realer Modelle ein;
- setzen geeignete statistische Risiko- und Verlustkonzepte für eine präzise mathematische Evaluierung statistischer Methoden ein;
- verwenden untere und obere Informationsschranken für die Analyse der Charakteristiken statistischer Schätzmethoden;
- sind mit grundlegenden statistischen Verteilungsmodellen vertraut, die sich auf der Theorie exponentieller Familien stützen;
- beherrschen die Modellierung realer Datenstrukturen wie kategorielle Daten, mehr- und hochdimensionale Daten, Daten in Bildern, Daten mit seriellen Abhängigkeiten;
- sie wenden die erlernten Techniken und Modelle sowie Computersimulationen für eine präzise mathematische Analyse aus der Praxis stammender statistischer Probleme an;
- sie können Resampling-Methode mathematisch analysieren und zielgerichtet anwenden;
- sind mit Konzepten der "large scale computational statistics" vertraut;
- sind mit fortgeschrittenen Werkzeugen der nicht-parametrischen Statistik und der Theorie empirischer Prozesse vertraut;
- erarbeiten selbstständig aktuelle Themen der statistischen Data science;
- evaluieren komplexe statistische Methoden und entwickeln diese für die Anwendung auf reale Probleme weiter.

Kompetenzen:

Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage,

- sich in ein mathematisches Thema im Bereich "Statistische Grundlagen der Data Science" einzuarbeiten und in einem Vortrag vorzustellen;
- wissenschaftliche Diskussionen in einem bekannten Kontext zu führen.

Arbeitsaufwand:

Präsenzzeit:

28 Stunden

Selbststudium:

62 Stunden

Lehrveranstaltung: Seminar (2 SWS) (Seminar)	
Prüfung: Präsentation (ca. 75 Minuten) **Prüfungsvorleistungen:** Teilnahme am Seminar	3 C

Prüfungsanforderungen: Selbständige Durchdringung und Darstellung komplexer mathematischer Sachverhalte im Bereich "Statistische Grundlagen der Data Science"	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.3147
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Mathematische Stochastik

Georg-August-Universität Göttingen **Modul B.Mat.3999: Bachelorabschlussmodul** *English title: Bachelor's Degree thesis project*	15 C 1 SWS

Lernziele/Kompetenzen: Nach dem erfolgreichen Abschluss des Moduls • kennen die Studierenden die Grundlagen guter wissenschaftlicher Praxis und können diese anwenden, • sie sind mit den Grundzügen des wissenschaftlichen Schreibens vertraut, z.B. hinsichtlich der formalen Struktur, • sie sind befähigt, ein Problem aus der Mathematical Data Science mit den Standardmethoden des Fachs im festgelegten Zeitraum zu bearbeiten, und • sie sind befähigt, ein selbständiges wissenschaftlich begründetes Urteil zu entwickeln und dieses in sprachlicher wie in formaler Hinsicht angemessen darzustellen.	**Arbeitsaufwand:** Präsenzzeit: 14 Stunden Selbststudium: 436 Stunden

Lehrveranstaltung: Einführung in das wissenschaftliche Arbeiten (Übung)	1 SWS
Prüfung: Bearbeitung der im Rahmen der Übung behandelten Themen am Beispiel der eigenen Bachelorarbeit, unbenotet **Prüfungsanforderungen:** Die Studierenden wenden die in der begleitenden Übung vermittelten Methoden auf Ihre Bachelorarbeit an. Sie erstellen beispielsweise Entwürfe für die einführenden Teile der Bachelorarbeit wie den theoretischen Hintergrund oder den Stand der Forschung.	3 C

Prüfung: Bachelorarbeit **Prüfungsvorleistungen:** B.Mat.3999.Ue: Übung **Prüfungsanforderungen:** In der Bachelorarbeit weisen die Studierenden die Befähigung nach, eine Fragestellung aus dem Gebiet "Mathematical Data Science" mit angemessenen Methoden des Fachs und unter Anleitung im festgelegten Zeitraum zu bearbeiten, ein selbständiges wissenschaftlich begründetes Urteil zu entwickeln, zu wissenschaftlich fundierten Aussagen zu gelangen und diese in sprachlicher wie in formaler Hinsicht angemessen darzustellen.	12 C

Zugangsvoraussetzungen: Gem. §11 (1) PStO	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: einmalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl:	

nicht begrenzt	

Bemerkungen:

Dozent/in: Lehrpersonen der Lehreinheit Mathematik

Georg-August-Universität Göttingen **Modul B.WIWI-QMW.0001: Lineare Modelle** *English title: Linear Models*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden: • erlernen die grundlegenden Konzepte der statistischen Modellierung mit Hilfe linearer Regressionsmodelle, • können die Annahmen des linearen Modells für gegebene Daten überprüfen und im Falle von Verletzungen der Annahmen geeignete Korrekturverfahren anwenden, • können die behandelten Verfahren in statistischer Software umsetzen und die Ergebnisse interpretieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Lineare Modelle (Vorlesung) *Inhalte*: Lineare Einfachregression (Modellannahmen, Kleinste-Quadrate-Schätzer, Tests und Konfidenzintervalle, Prognosen), multiple Regressionsmodelle (Modellannahmen, Modelldarstellung in Matrixnotation, Kleinste-Quadrate-Schätzer und ihre Eigenschaften, Tests und Konfidenzintervalle), Modellierung metrischer und kategorialer Einflussgrößen (Polynome, Splines, Dummy-Kodierung, Effekt-Kodierung, Varianzanalyse), Modelldiagnose, Modellwahl, Variablenselektion, Erweiterungen des klassischen Regressionsmodells (allgemeine lineare Modelle, Ridge-Regression, LASSO).	2 SWS
Lehrveranstaltung: Lineare Modelle (Übung) *Inhalte*: Im Rahmen der begleitenden Übung vertiefen die Studierenden die Kenntnisse aus der Vorlesung anhand ausgewählter Fragestellungen.	2 SWS
Prüfung: Klausur (90 Minuten)	6 C

Prüfungsanforderungen: Die Studierenden weisen in der Modulprüfung nach, dass sie: • mit den grundlegenden Annahmen und Eigenschaften linearer Modelle vertraut sind und sie diese in praktischen Datenanalysen einsetzen können, • in der Lage sind, Annahmen des linearen Modells kritisch zu prüfen und geeignete Korrekturverfahren zu identifizieren, • lineare Modelle und ihre Erweiterungen mit Hilfe statistischer Software umsetzen und die entsprechenden Ergebnisse inhaltlich interpretieren können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Gute Kenntnisse des Basismoduls Statistik
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Thomas Kneib
Angebotshäufigkeit: jedes 2. Semester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.WIWI-QMW.0008: Praktikum Statistische Modellierung** *English title: Consulting statistical modeling*	9 C 2 SWS
Lernziele/Kompetenzen: Die Studierenden: • erlenen die praktische Durchführung statistischer Analysen, • erlernen die Präsentation statistischer Ergebnisse, • können für praktische Probleme geeignete statistische Verfahren auswählen und anwenden.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 242 Stunden
Lehrveranstaltung: Praktikums Statistische Modellierung (Seminar) *Inhalte*: Im Rahmen des Praktikums Statistische Modellierung bearbeiten die Studierenden in Gruppen von bis zu vier Personen ein Anwendungsproblem mit Hilfe basierend auf Methoden der statistischen Modellierung. Das Praktikum statistische Modellierung wird in der Regel in Kooperation mit einen Praxispartner durchgeführt.	2 SWS
Prüfung: Hausarbeit (max. 30 Seiten) **Prüfungsvorleistungen:** 2 Präsentationen (je ca. 30 Minuten)	9 C
Prüfungsanforderungen: Im Rahmen des Praktikums bereiten die Studierenden die vom Anwendungspartner zur Verfügung gestellten Daten auf, untersuchen diese explorativ, wählen ein geeignetes Modell und führen die entsprechenden statistischen Analysen durch. Im Rahmen der Hausarbeit werden alle Schritte dieses Prozesses und insbesondere die erzielten Ergebnisse dokumentiert.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Thomas Kneib
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 6
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.WIWI-VWL.0007: Einführung in die Ökonometrie** *English title: Introduction to Econometrics*	6 C 6 SWS
Lernziele/Kompetenzen: Das Modul gibt eine umfassende Einführung in die ökonometrische Analyse ökonomischer Fragestellungen. Die Studierenden erlernen mit Hilfe der Methoden linearer Regressionsanalyse erste eigene empirische Studien durchzuführen. Die vermittelten Kompetenzen beinhalten die Spezifikation von ökonometrischen Modellen, die Modellselektion und –schätzung. Darüber hinaus werden Studierende mit ersten Problemen im Bereich der linearen Regression wie beispielsweise Heteroskedastizität und Autokorrelation vertraut gemacht. Dieses Modul bildet das Fundament für weiterführende Ökonometrie Veranstaltungen.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Einführung in die Ökonometrie (Vorlesung) *Inhalte*: 1. Einführung in lineare multiple Regressionsmodelle, Modellspezifikation, KQ-Schätzung, Prognose und Modellselektion, Multikollinearität und partielle Regression. 2. Lineares Regressionsmodell mit normalverteilten Störtermen, Maximum-Likelihood-Schätzung, Intervallschätzung, Hypothesentests 3. Asymptotische Eigenschaften des KQ- und GLS Schätzers 4. Lineares Regressionsmodell mit verallgemeinerter Kovarianzmatrix, Modelle mit autokorrelierten und heteroskedastischen Fehlertermen, Testen auf Autokorrelation und Heteroskedastizität.	2 SWS
Lehrveranstaltung: Einführung in die Ökonometrie (Übung) *Inhalte*: Die Großübung vertieft die Inhalte der Vorlesung anhand von Rechenaufgaben mit ökonomischen Fragestellungen und Datensätzen. Weiterhin werden theoretische Konzepte aus der Vorlesung detailliert hergeleitet.	2 SWS
Lehrveranstaltung: Einführung in die Ökonometrie (Tutorium) *Inhalte*: Das Tutorium vertieft die Inhalte der Vorlesung und Großübung anhand von Rechenaufgaben. Ein großer Teil beinhaltet das Schätzen von ökonometrischen Modellen mit realen Daten und mit Hilfe des Softwareprogramms Eviews.	2 SWS
Prüfung: Klausur (90 Minuten)	6 C
Prüfungsanforderungen: Die Studierenden zeigen, dass sie einfache ökonometrische Konzepte verstanden haben. Darüber hinaus sind sie in der Lage, diese auf reale wirtschaftliche Fragestellungen anzuwenden.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-OPH.0002 Mathematik B.WIWI-OPH.0006 Statistik

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Helmut Herwartz
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 5
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.WIWI-WB.0001: Wissenschaftliches Programmieren** *English title: Scientific Programming*	3 C 1 SWS
Lernziele/Kompetenzen: Die Studierenden: • kennen die grundlegende Struktur und Arbeitsweise der Programmierumgebung MATLAB und die wichtigsten Methoden zur Programmierung mit Matrizen, • erlernen die grundlegenden Konzepte und Denkweisen des wissenschaftlichen Programmierens, • erlernen die Bedienung und effiziente Nutzung von fortgeschrittenen Entwicklungswerkzeugen, wie dem Debugger und dem Profiler, • können Probleme visualisieren und professionelle Grafiken erzeugen, • sind in der Lage, eigenständig Probleme in MATLAB durch eigene Programmierung zu lösen – beispielsweise im Rahmen einer wissenschaftlichen Arbeit.	**Arbeitsaufwand:** Präsenzzeit: 18 Stunden Selbststudium: 72 Stunden
Lehrveranstaltung: Wissenschaftliches Programmieren (Übung) *Inhalte*: Die Veranstaltung zielt darauf ab, Studierende in die wissenschaftliche Programmierung mit der statistischen Standardanwendung „MathWorks MATLAB" einzuführen. Die Basic-Programmiersprache eignet sich hervorragend, um die grundlegenden Konzepte des Programmierens sowie der numerischen Datenverarbeitung zu vermitteln und erlaubt es den Studierenden, wichtige Schlüsselkompetenzen zu erwerben. Es wird ein modernes Skript in deutscher und englischer Sprache eingesetzt, das die Teilnehmer zur Anwendung motiviert und ihnen ermöglicht, ihren eigenen Lernerfolg während der Durchführung des Kurses an praktischen Übungsaufgaben nachzuvollziehen. Themen 1. Benutzeroberfläche 2. Daten und Operationen 3. Funktionen 4. Programmierkonzepte 5. Entwicklungswerkzeuge 6. 2D- und 3D-Grafiken 7. Fortgeschrittene Lösungsverfahren	1 SWS
Prüfung: Klausur (60 Minuten)	3 C
Prüfungsanforderungen: Kenntnis der Bedienung und Funktionsweise von MathWorks MATLAB. Anwendung von MATLAB-eigenen Operationen und Funktionen – insbesondere in Bezug auf Matrizen und lineare Algebra. Wissen über Import, Verarbeitung und statistischer Auswertung von Daten. Lösen von kurzen - auch grafischen - Programmieraufgaben. Wissen von Programmierkonzepten (z.B. Schleifen und Verzweigungen). Kenntnis des „guten Programmierstils".	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-OPH.0002 Mathematik, B.WIWI-OPH.0006 Statistik
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Helmut Herwartz
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 5
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen Module M.WIWI-QMW.0002: Advanced Statistical Inference (Likelihood & Bayes)	6 C 4 WLH

Learning outcome, core skills: Upon completion of the module, the students have acquired the following competencies: • foundations and general properties of likelihood-based inference in statistics, • bayesian approaches to statistical learning and their properties, • implementation of both approaches in statistical software using appropriate numerical procedures.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Advanced Statistical Inference (Likelihood & Baye) (Lecture) *Contents*: The likelihood function and likelihood principles, maximum likelihood estimates and their properties, likelihood-based tests and confidence intervals (derived from Wald, score, and likelihood ratio statistics), expectation maximization algorithm, Bootstrap procedures (estimates for the standard deviation, the bias and confidence intervals), Bayes theorem, Bayes estimates, Bayesian credible intervals, prior choices, computational approaches for Bayesian inference, model choice, predictions	2 WLH
Course: Advanced Statistical Inference (Likelihood & Bayes) (Exercise) *Contents*: The likelihood function and likelihood principles, maximum likelihood estimates and their properties, likelihood-based tests and confidence intervals (derived from Wald, score, and likelihood ratio statistics), expectation maximization algorithm, Bootstrap procedures (estimates for the standard deviation, the bias and confidence intervals), Bayes theorem, Bayes estimates, Bayesian credible intervals, prior choices, computational approaches for Bayesian inference, model choice, predictions	2 WLH
Examination: Written examination (90 minutes) or oral examination (approx. 20 minutes)	6 C

Examination requirements: The students demonstrate their general understanding of likelihood-based and Bayesian inference for different types of applications and research questions. They know about the advantages and disadvantages as well as general properties of both approaches, can critically assess the appropriateness for specific problems, and can implement them in statistical software. The exam covers contents of both the lecture and the exercise class.	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of mathematics and statistics
Language: English	**Person responsible for module:** Prof. Dr. Thomas Kneib
Course frequency: every year	**Duration:** 1 semester[s]

Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: not limited	

Additional notes and regulations:
The actual examination will be published at the beginning of the semester.

Georg-August-Universität Göttingen Module M.WIWI-QMW.0009: Introduction to Time Series Analysis	6 C 4 WLH

Learning outcome, core skills: The students: • learn concepts and techniques related to the analysis of time series and forecasting, • gain a solid understanding of the stochastic mechanisms underlying time series data, • learn how to analyse time series using statistical software packages and how to interpret the results obtained.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Introduction to Time Series Analysis (Lecture) *Contents*: Classical time series decomposition analysis (moving averages, transformations of time series, parametric trend estimates, seasonal and cyclic components), exponential smoothing, stochastic models for time series (multivariate normal distribution, autocovariance and autocorrelation function), stationarity,spectral analysis, general linear time series models and their properties, ARMA models, ARIMA models, ARCH and GARCH models.	2 WLH
Course: Introduction to Time Series Analysis (Tutorial) *Contents*: Practical and theoretical exercises covering the content of the lecture. Implementation of time series models and estimation by common statistical software (e.g. R or Matlab). Interpretation of estimation results.	2 WLH
Examination: Written examination (90 minutes)	6 C

Examination requirements: The students show their ability to analyze time series using specific statistical techniques, can derive and interpret properties of stochastic models for time series, and can decide on appropriate models for given time series data. The students are able to implement time series analyses using statistical software and to interpret the corresponding results. The exam covers contents of both the lecture and the exercise class.	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in statistics M.WIWI-QMW.0004 Econometrics I
Language: English	**Person responsible for module:** Prof. Dr. Helmut Herwartz
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2 - 3

Maximum number of students: 50	

Georg-August-Universität Göttingen **Modul SK.FS.EN-FN-C1-1: Scientific English I - C1.1 - Fachsprache Englisch für die Naturwissenschaften I** *English title: Scientific English I*	6 C (Anteil SK: 6 C) 4 SWS
Lernziele/Kompetenzen: Weiterentwicklung bereits vorhandener diskursiver Fertigkeiten und Kompetenzen auf einem über die Stufe B2 des *Gemeinsamen europäischen Referenzrahmens für Sprachen* hinausgehenden Niveau, mit Hilfe derer auch jede Art von beruflicher und naturwissenschaftlicher Sprachhandlung auf Englisch vollzogen werden kann, wie z.B.: • Fähigkeit, mühelos an allen Unterhaltungen, Diskussionen und Verhandlungen mit allgemeinen und naturwissenschaftlichen Inhalten teilzunehmen und dabei die Gesprächspartner problemlos zu verstehen sowie auf ihre Beiträge differenziert einzugehen bzw. eigene Beiträge inhaltlich komplex und sprachlich angemessen zu formulieren; • Fähigkeit, auch umfangreichere naturwissenschaftliche Publikationen zu allen Themen zu verstehen und unter Anwendung spezifischer Sprachstrukturen und -konventionen sprachlich und stilistisch sicher selbst zu verfassen; • Erwerb spezifischer sprachlicher und stilistischer Strukturen der englischen Sprache sowie Entwicklung eines differenzierten naturwissenschaftlichen Wortschatzes; • Ausbau des operativen landeskundlichen und interkulturellen Wissens über die englischsprachigen Länder im beruflichen und naturwissenschaftlichen Kontext.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Scientific English I (Übung) *Inhalte*: a. Studying in the sciences / undergraduate research b. Working in the sciences (including key terminology) c. Scientific misconduct / plagiarism d. Controversial topics in science e. Scientific writing: i. Science essay structure, style and format ii. Professional correspondence (email) in a scientific context f. Presenting / explaining a basic scientific process or procedure g. Discussing current scientific developments In der Lehrveranstaltung werden die vier Sprachfertigkeiten und vier Kommunikationsmodi praktisch geübt. Der Kompetenzzuwachs basiert auf Self Assessment, Peer Assessment und dem Feedback der Lehrkraft zu den von den Studierenden erstellten sprachlichen Produkten bzw. bearbeiteten Aufgaben.	4 SWS
Prüfung: Fremdsprachenportfolio: 6 Aufträge (Gesamtumfang ca. 210 Min., schriftl. Arbeitsaufträge von insg. max. 1500 Wörtern) für die vier Fertigkeiten	6 C

Hörverstehen, Leseverstehen, Schriftl. Ausdruck und Mündl. Ausdruck (jeweils 25 % der Gesamtnote) **Prüfungsvorleistungen:** regelmäßige und aktive Teilnahme **Prüfungsanforderungen:** Das Fremdsprachenportfolio umfasst separate oder integrierte Arbeitsaufträge zur Überprüfung der Kommunikationsmodi „Rezeption“, „Produktion“, „Interaktion“ und „Mediation“ und dient dem Nachweis von sprachlichen Handlungskompetenzen in interkulturellen und naturwissenschaftlichen Kontexten in Studium, Forschung, Beruf und Alltag unter Anwendung der vier Fertigkeiten Hören, Sprechen, Lesen und Schreiben, d.h. dem Nachweis der Fähigkeit, rezeptiv wie produktiv auf eine dem Niveau C1.1 des *Gemeinsamen europäischen Referenzrahmens für Sprachen* angemessene Art mit mündlichen und schriftlichen Kommunikationssituationen umzugehen. Der genaue Umfang und die Zusammensetzung der Arbeitsaufträge werden in der ersten Lehrveranstaltungssitzung und der Lernplattform bekanntgegeben.	

Zugangsvoraussetzungen: SK.FS.E-B2-2 (Modul Mittelstufe II) oder Einstufungstest mit abgeschlossenem Niveau B2 des GER	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Jeffrey Park
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Fakultät für Mathematik und Informatik:

Nach Beschluss des Fakultätsrats der Fakultät für Mathematik und Informatik vom 10.01.2024 hat das Präsidium der Georg-August-Universität Göttingen am 31.01.2024 die Neufassung des Modulverzeichnisses zur Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang „Mathematik“ genehmigt (§ 44 Abs. 1 Satz 2 NHG, §§ 37 Abs. 1 Satz 3 Nr. 5 b), 44 Abs. 1 Satz 3 NHG).

Die Neufassung des Modulverzeichnisses tritt nach deren Bekanntmachung in den Amtlichen Mitteilungen II zum 01.04.2024 in Kraft.

Georg-August-Universität
Göttingen

Modulverzeichnis

zu der Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang "Mathematik" (Amtliche Mitteilungen I Nr. 14/2013 S. 313, zuletzt geaendert durch Amtliche Mitteilungen I Nr. 4/2024 S. 27)

Module

Übersicht nach Modulgruppen

I. Study tracks in the Master's Degree programme in Mathematics (M.Sc.)

In the Master's Degree programme in Mathematics, one of the following study tracks has to be chosen, whereas modules with a total of at least 90 C have to be completed successfully in accordance with the following regulations. The regulations for the modules that can be chosen within the scope of a study focus can be found in No. II "Elective courses in Mathematics (graduate studies)".

Im Master-Studiengang „Mathematik“ ist eines der nachfolgenden Studienprofile zu wählen, wobei nach Maßgabe der folgenden Bestimmungen Module im Umfang von wenigstens 90 C erfolgreich zu absolvieren sind. Die im Rahmen eines Schwerpunktes wählbaren Module sind unter "II. Elective courses in Mathematics (graduate studies)" geregelt.

1. Study track F "Research-oriented - general"

In the study track F "Research-oriented - general" modules have to be completed successfully according to the regulations below.

Im Studienprofil F „Forschungsorientiert - allgemein“ sind Module nach Maßgabe der nachstehenden Bestimmungen erfolgreich zu absolvieren.

a. Elective compulsory modules in Mathematics (60 C)

In the study track F, elective compulsory modules in the subject mathematics with a total of at least 60 C have to be completed successfully according to the following regulations:

Im Studienprofil F müssen Wahlpflichtmodule im Fach Mathematik im Umfang von insgesamt mindestens 60 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden:

i) In the study foci SP 1 or SP 2, modules with a total of at least 12 C have to be completed successfully, thereof at least a seminar module or an advanced seminar module with at least 3C (M.Mat.481*, M.Mat.482*, M.Mat.491*, M.Mat.492*). If the Master's thesis is in one out of these two study foci, a total of at least 6 C of the modules out of the other study focus have to be completed successfully.

Aus den Schwerpunkten SP 1 oder SP 2 müssen Module im Umfang von insgesamt wenigstens 12 C erfolgreich absolviert werden, davon mindestens ein Seminar- oder Oberseminarmodul (M.Mat.481*, M.Mat.482*, M.Mat.491*, M.Mat.492*) im Umfang von wenigstens 3 C; ist einer dieser beiden Schwerpunkte der Studienschwerpunkt der Masterarbeit, so müssen mindestens 6 C aus Modulen des anderen Schwerpunkts erworben werden.

ii) In the study foci SP 3 or SP 4, modules with a total of at least 12 C have to be completed successfully, thereof at least a seminar module or an advanced seminar module with at least 3C (M.Mat.483*, M.Mat.484*, M.Mat.493*, M.Mat.494*). If the Master's thesis is in one out of these two study foci, a total of at least 6 C of the modules out of the other study focus have to be completed successfully.

Aus den Schwerpunkten SP 3 oder SP 4 müssen Module im Umfang von insgesamt wenigstens 12 C erfolgreich absolviert werden, davon mindestens ein Seminar- oder Oberseminarmodul (M.Mat.483*, M.Mat.484*, M.Mat.493*, M.Mat.494*) im Umfang von wenigstens 3 C; ist einer dieser beiden Schwerpunkte der Studienschwerpunkt der Masterarbeit, so müssen mindestens 6 C aus Modulen des anderen Schwerpunkts erworben werden.

iii) Further modules can be chosen freely out of the modules offered in all four mathematical study foci.

Darüber hinaus kann frei aus den angebotenen Modulen aller vier mathematischen Studienschwerpunkte gewählt werden.

b. Elective compulsory modules in the minor subject (18 C)

In the study track F, modules with at total of at least 18 C have to be completed successfully in one out of the following minor subjects: Astrophysics, Business Administration, Chemistry, Computer Science, Philosophy, Physics, Economics. The regulations for the modules to choose from in each case can be found in No.III "Minor subjects in the graduate programme in Mathematics".

Im Studienprofil F sind Module im Gesamtumfang von wenigstens 18 C in einem der folgenden Nebenfächer erfolgreich zu absolvieren: Astrophysik, Betriebswirtschaftslehre, Chemie, Informatik, Philosophie, Physik, Volkswirtschaftslehre. Die jeweils wählbaren Module sind in "III. Minor subjects in the graduate programme in Mathematics" geregelt.

c. Elective modules in the key competencies area (12 C)

Modules with a total of at least 12 C have to be completed successfully, among them one out of the key competencies modules offered by the Unit Mathematics, according to the regulations in No. IV. "Key competencies in the graduate programme in Mathematics". The remaining modules can be chosen freely from the key competencies modules offered by the Unit Mathematics, according to the regulations in No. IV. "Key competencies in the graduate programme in Mathematics", or from the cross-faculty key competencies offer. The choice of other modules (alternative modules) is only possible with the approval of the dean of students of the faculty that offers the module. The choice of an alternative module has to be reported to the Study Office Mathematics in advance.

Es sind Module im Gesamtumfang von wenigstens 12 C erfolgreich zu absolvieren, darunter eines der Schlüsselkompetenzmodule aus dem Angebot der Lehreinheit Mathematik nach "IV. Key competencies in the graduate programme in Mathematics". Die übrigen Module können frei aus den unter IV. "Schlüsselkompetenzmodule im Masterstudium" genannten Wahlmodulen aus dem Angebot der Lehreinheit Mathematik oder aus dem universitätsweiten Schlüsselkompetenzangebot gewählt werden. Die Belegung anderer Module (Alternativmodule) ist mit Zustimmung der Studiendekanin oder des Studiendekans der Fakultät, die das Modul anbietet, ebenfalls möglich. Die Belegung eines Alternativmoduls ist dem Studienbüro vorab anzuzeigen.

2. Study track Phy "Physics"

In the research-oriented study track Phy "Physics", modules below have to be completed successfully according to the regulations.

Im forschungsorientierten Studienprofil Phy "Physik" sind Module nach Maßgabe der nachstehenden Bestimmungen erfolgreich zu absolvieren.

a. Elective compulsory modules in Mathematics (60 C)

In the study track Phy, elective compulsory modules covering a total of at least 60 C have to be completed successfully according to the following regulations:

Im Studienprofil Phy müssen Wahlpflichtmodule im Umfang von insgesamt mindestens 60 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i) In the study foci SP 3 or SP 4, ective compulsory modules with a total of at least 12 C have to be completed successfully, thereof at least a seminar module or an advanced seminar module with at least 3 C (M.Mat.483*, M.Mat.484*, M.Mat.493*, M.Mat.494*).

Es müssen Wahlpflichtmodule aus den Schwerpunkten SP 3 oder SP 4 im Gesamtumfang von wenigstens 12 C erfolgreich absolviert werden, davon mindestens ein Seminar- oder Oberseminarmodul im Umfang von wenigstens 3 C.

ii) In the cycles "Mathematical Methods in Physics", "Analysis of Partial Differential Equations", "Differential Geometry", "Algebraic Topology", "Non-commutative Geometry" and "Groups, Geometry and Dynamical Systems", modules with a total of at least 12 C have to be completed successfully, thereof at least a seminar module or an advanced seminar module with at least 3C.

Es müssen Module im Gesamtumfang von mindestens 12 C aus den Zyklen Mathematische Methoden der Physik, Analysis partieller Differenzialgleichungen, Differenzialgeometrie, Algebraische Topologie, Nichtkommutative Geometrie sowie Gruppen, Geometrie und Dynamische Systeme erfolgreich absolviert werden, davon mindestens ein Seminar- oder Oberseminarmodul im Umfang von wenigstens 3 C.

iii) Further moduls can be chosen freely out the modules offered in all four mathematical study foci SP1-4. Additionally, modules in the section No. III.6. "Physics" can be chosen freely, however this option is restricted to modules with a total of at most 12 C.

Ferner kann frei aus den angebotenen Modulen aller vier mathematischen Studienschwerpunkte gewählt werden. Weiterhin können Module im Gesamtumfang von maximal 12 C aus dem Bereich "III.6. Physics" frei gewählt werden.

b. Elective compulsory modules in the minor subject (18 C)

In the study track Phy, in the minor subject "Physics", modules with a total of at least 18 C have to be completed successfully. The regulations for the modules that can be chosen can be found in No.III "Minor subjects in the graduate programme in Mathematics".

Im Studienprofil Phy sind Module im Gesamtumfang von mindestens 18 C im Nebenfach Physik erfolgreich zu absolvieren. Die jeweils wählbaren Module sind in "III. Minor subjects in the graduate programme in Mathematics" geregelt.

c. Elective modules of the key competencies area (12 C)

At least one key competencies module out of the offer of the Faculty of Physics or out of the offer of the Unit Mathematics has to be completed successfully. Furthermore, modules can be chosen freely from the key competencies modules offered by the Unit Mathematics, according to the regulations in No. IV. "Key competencies in the graduate programme in Mathematics", or from the cross-faculty key competencies offer. The choice of other modules (alternative modules) is only possible with the approval of the dean of students of the faculty that offers the module. The choice of an alternative module has to be reported to the Study Office Mathematics in advance.

Es ist ein Schlüsselkompetenzmodul aus dem Angebot der Fakultät für Physik oder eines aus dem Angebot der Lehreinheit Mathematik erfolgreich zu absolvieren. Ferner können Module aus den unter IV. "Schlüsselkompetenzmodule im Masterstudium" genannten Wahlmodulen aus dem Angebot der Lehreinheit Mathematik oder aus dem universitätsweiten Schlüsselkompetenzangebot frei gewählt werden. Die Belegung anderer Module (Alternativmodule) ist mit Zustimmung der Studiendekanin oder des Studiendekans der Fakultät, die das Modul anbietet, ebenfalls möglich. Die Belegung eines Alternativmoduls ist dem Studienbüro vorab anzuzeigen.

3. Study track MDS "Mathematical Data Science"

In the study track MDS "Mathematical Data Science" modules have to be completed successfully according to the regulations below. In the study track "Mathematical Data Science" the study foci SP 3 or SP 4 are permitted as study focus of the Master's thesis, only.

Im forschungsorientierten Studienprofil MDS "Mathematical Data Science" sind Module nach Maßgabe der nachstehenden Bestimmungen erfolgreich zu absolvieren. Als Schwerpunkt der Masterarbeit sind im Studienprofil Mathematical Data Sience nur die Schwerpunkte SP 3 oder SP 4 zugelassen.

a. Elective compulsory modules in Mathematics (60 C)

In the study track MDS, elective compulsory modules in the subject mathematics with a total of at least 60 C have to be completed successfully according to the following regulations:

Im Studienprofil MDS müssen Wahlpflichtmodule im Umfang von insgesamt mindestens 60 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

aa. Elective compulsory modules in SP 3

In the cycles listed below, modules with a total of at least 12 C have to be completed successfully, thereof at least a seminar module or an advanced seminar module with at least 3C.

Es müssen Module im Gesamtumfang von mindestens 12 C, davon mindestens ein Seminar- oder Oberseminarmodul im Umfang von wenigstens 3 C, aus den folgenden Zyklen absolviert werden.

- Inverse problems
- Optimisation
- Variational analysis
- Image and geometry processing
- Scientific computing / applied mathematics

bb. Elective compulsory modules in SP 4

In the cycles listed below, modules with a total of at least 12 C have to be completed successfully, thereof at least a seminar module or an advanced seminar module with at least 3C.

Es müssen Module im Gesamtumfang von mindestens 12 C, davon mindestens ein Seminar- oder Oberseminarmodul im Umfang von wenigstens 3 C, aus den folgenden Zyklen absolviert werden.

- Applied and mathematical stochastics
- Statistical modelling and inference
- Multivariate and non-Euclidean statistics
- Statistical foundations of data science

cc. Practical course

One out of the following practical course modules with 10 C has to be completed successfully:

Eines der folgenden Praktikumsmodule im Umfang von 10 C muss erfolgreich absolviert werden:

dd. Computer science

In the area "Computer science", one out of the following modules has to be completed successfully.

Es muss eines der folgenden Module erfolgreich absolviert werden.

ee. Elective modules

In order to achieve 60 C, modules out of the four study foci in Mathematics can be added In addition, modules with a total of at most 12 C can be chosen in the subject "Computer science" as listed in No.III.4 "Computer Science". However, those listed in No.I.4.a.dd) "Computer Science" are recommended.

Zum Auffüllen auf 60 C kann frei aus den angebotenen Modulen aller vier mathematischen Studienschwerpunkte gewählt werden. Weiterhin können Module im Gesamtumfang von maximal 12 C aus dem Bereich III.4 "Computer Science" frei gewählt werden, empfohlen werden die im Abschnitt .I.4.a.dd) "Computer Science" gelisteten Module.

b. Elective compulsory modules in the minor subject (18 C)

In the study track MDS, in the minor subject "Computer science" modules with a total of at least 18 C have to be completed successfully. The regulations can be found in No.III.4) "Computer science". However, those listed in No.I.4.a.dd) "Computer Science" are recommended.

Im Studienprofil MDS sind Module im Gesamtumfang von mindestens 18 C im Nebenfach Informatik erfolgreich zu absolvieren. Die wählbaren Module sind in Nr. III.4) "Computer science" geregelt, empfohlen werden die im Abschnitt I.4.a.dd) "Computer Science" gelisteten Module.

c. Elective modules in the key competencies area (12 C)

One out of the key competencies modules offered by the Unit Mathematics, according to the regulations in No. IV. "Key competencies in the graduate programme in Mathematics", or from the modules according to section dd. "Computer science" has to be completed successfully.

Further modules may be chosen freely from the key competencies modules offered by the Unit Mathematics, according to the regulations in No. IV. "Key competencies in the graduate programme in Mathematics", or from the cross-faculty key competencies offer.

The choice of other modules (alternative modules) is only possible with the approval of the dean of students of the faculty that offers the module. The choice of an alternative module has to be reported to the Study Office Mathematics in advance.

Es ist ein Modul aus den in Nr. IV) "Schlüsselkompetenzmodule im Masterstudium" genannten Wahlmodulen aus dem Angebot der Lehreinheit Mathematik oder aus den im Abschnitt iv) „Informatik“ gelisteten Modulen zu belegen.

Ferner können weitere Module aus den unter IV. "Schlüsselkompetenzmodule im Masterstudium" genannten Wahlmodulen aus dem Angebot der Lehreinheit Mathematik oder aus dem universitätsweiten Schlüsselkompetenzangebot frei gewählt werden.

Die Belegung anderer Module (Alternativmodule) ist mit Zustimmung der Studiendekanin oder des Studiendekans der Fakultät, die das Modul anbietet, ebenfalls möglich. Die Belegung eines Alternativmoduls ist dem Studienbüro Mathematik vorab anzuzeigen.

II. Elective courses in Mathematics (graduate studies)

1. Elective compulsory modules in study focus SP 1 "Analysis, geometry, topology"

2. Elective compulsory modules in study focus SP 2 "Algebra, geometry, number theory"

3. Elective compulsory modules in study focus SP 3 "Numerical and applied mathematics"

4. Elective compulsory modules in study focus SP 4 "Mathematical stochastics"

III. Minor subjects in the graduate programme in Mathematics

1. Astrophysics

In "Astrophysics" as a minor subject the following module has to be completed successfully. Furthermore, all modules with module number B.Phy.55** and M.Phy.55** may be chosen.

Im Nebenfach "Astrophysik" ist folgendes Modul erfolgreich zu absolvieren. Weiterhin stehen alle Module mit Modulnummern B.phy.55** und M.Phy.55** zur Auswahl.

2. Business Administration

In "Business Administration" as a minor subject the following modules may be chosen.

Im Nebenfach "Betriebswirtschaftslehre" stehen folgende Module zur Auswahl:

3. Chemistry

In "Chemistry" as a minor subject the following module may be chosen. Furthermore all modules in Chemistry out of the graduate programm in Chemistry (module number M.Che.****) can be chosen. Selection of modules out of the undergraduate programme in Chemistry may be selected provided approval through the dean of studies of the Faculty of Chemistry. In this case the Study Office Mathematics must be informed beforehand.

Im Nebenfach "Chemie" stehen folgende Module zur Auswahl. Darüber hinaus können alle Chemie-Module aus dem Master-Studiengang "Chemie" (Modul-Nummern M.Che.****) gewählt werden. Die Belegung von Chemie-Modulen aus dem Bachelor-Studiengang "Chemie" ist mit Zustimmung durch die Studiendekanin oder den Studiendekan der Fakultät für Chemie zulässig. Die Belegung eines solchen Moduls ist dem Studienbüro vorab anzuzeigen.

4. Computer Science

a.

In "Computer Science" as a minor subject all the modules with module number B.Inf.**** or M.Inf.**** can be chosen with the exception of the following modules.

Im Nebenfach „Informatik“ stehen alle Module mit den Modul-Nummern B.Inf.**** und M.Inf.**** zur Auswahl. Davon abweichend können folgende Module nicht eingebracht werden.

- B.Inf.1101: Grundlagen der Informatik und Programmierung
- B.Inf.1102: Grundlagen der Praktischen Informatik
- B.Inf.1801: Programmierkurs

b.

In addition, following modules may be chosen.

Weiterhin können folgende Module eingebracht werden.

5. Philosophy

In "Philosophy" as a minor subject the following modules can be chosen; for at least one of the selected modules a term paper has to be prepared. Advanced studies modules may be chosen after the respective basic studies module has successfully been completed, only.

Im Nebenfach "Philosophie" stehen folgende Module zur Auswahl; in einem der gewählten Module muss eine Hausarbeit angefertigt werden. Aufbaumodule dürfen nur belegt werden, wenn zuvor die entsprechenden Basismodule erfolgreich abgeschlossen wurden.

6. Physics

In "Physics" as a minor subject all modules with module number B.Phy.**** or M.Phy.*** can be chosen, with the exception of the following module:

Im Nebenfach "Physik" stehen alle Module mit den Modul-Nummer B.Phy.**** oder M.Phy.**** zur Auswahl. Davon abweichend kann folgendes Modul nicht absolviert werden:

- B.Phy.1301 "Rechenmethoden der Physik"

7. Economics

In "Economics" as a minor subject the following modules can be chosen:

Im Nebenfach "Volkswirtschaftslehre" stehen folgende Module zur Auswahl:

IV. Key competencies in the graduate programme in Mathematics

Within the graduate programme in Mathematics, the Unit Mathematics offers the following modules.

Die Lehreinheit Mathematik bietet im Master-Studiengang "Mathematik" folgende Schlüsselkompetenzmodule an.

V. Master's thesis

By successfully completing a Master's thesis students earn 30 C.

VI. Modulpakete "Mathematik" im Umfang von 36 C oder 18 C (belegbar ausschließlich im Rahmen eines anderen geeigneten Master-Studiengangs)

This paragraph is addressed to students in non-mathematics M.A. graduate programmes, only.

Die Lehreinheit Mathematik bietet folgende Modulpakete für Studierende anderer Studiengänge an. Studierende des Master-Studiengangs „Mathematik“ können das Modul B.Mat.1400 und die Module der Form B.Mat.2XXX ausschließlich als freiwillige Zusatzprüfungen absolvieren; dabei fließt die Note nicht in das Gesamtergebnis der Masterprüfung im Master-Studiengang „Mathematik“ ein.

1. Zugangsvoraussetzungen

Für die Modulpakete „Mathematik“ im Umfang von 36 C bzw. 18 C gelten folgende gemeinsame Zugangsvoraussetzungen:

Nachweis von Leistungen aus Grundlagen der Mathematik im Umfang von insgesamt wenigstens 33 C, darunter Grundlagen der Analysis im Umfang von insgesamt wenigstens 18 C (z.B. durch die Module B.Mat.0011 und B.Mat.0021) sowie der Analytischen Geometrie und Linearen Algebra im

Umfang von insgesamt wenigstens 15 C (z.B. durch die Module B.Mat.0012 und B.Mat.0026). Ferner der Nachweis weiterführender Leistungen der reinen oder angewandten Mathematik im Umfang von insgesamt wenigstens 21 C.

2. Modulpaket "Mathematik" im Umfang von 36 C

Es müssen aus dem nachfolgenden Angebot Module im Umfang von insgesamt wenigstens 36 C erfolgreich absolviert werden. Es können weiterführende mathematische Module des Bachelor-Studiengangs „Mathematik“ der Georg-August-Universität Göttingen (Modulnummern B.Mat.3XXX) oder mathematische Wahlpflichtmodule aus dem Modulhverzeichnis des Master-Studiengangs „Mathematik“ der Georg-August-Universität Göttingen (Modulnummern M.Mat.4XXX) absolviert werden. Empfohlen werden folgende Module:

3. Modulpaket "Mathematik" im Umfang von 18 C

Es müssen aus dem nachfolgenden Angebot Module im Umfang von insgesamt wenigstens 18 C erfolgreich absolviert werden. Es können weiterführende mathematische Module des Bachelor-Studiengangs „Mathematik“ der Georg-August-Universität Göttingen (Modulnummern B.Mat.3XXX) oder mathematische Wahlpflichtmodule aus dem Modulverzeichnis des Master-Studiengangs „Mathematik“ der Georg-August-Universität Göttingen (Modulnummern M.Mat.4XXX) absolviert werden. Empfohlen werden folgende Module:

VII. Methods of examination and glossary

Methods of examination

As far as in this directory of modules a module description is published in the English language the following mapping applies:

Soweit in diesem Modulverzeichnis Modulbeschreibungen in englischer Sprache veröffentlicht werden, gilt für die verwendeten Prüfungsformen nachfolgende Zuordnung:

- Oral examination = mündliche Prüfung [§ 15 Abs. 8 APO]
- Written examination = Klausur [§ 15 Abs. 9 APO]
- Term paper = Hausarbeit [§ 15 Abs. 11 APO]
- Presentation = Präsentation [§ 15 Abs. 12 APO]
- Presentation and written report = Präsentation mit schriftlicher Ausarbeitung [§ 15 Abs. 12 APO]

Glossary

APO = Allgemeinen Prüfungsordnung für Bachelor- und Master-Studiengänge sowie sonstige Studienangebote an der Universität Göttingen

PStO = Prüfungs- und Studienordnung für den Bachelor/Master-Studiengang "Mathematik"

WLH = Weekly lecture hours = SWS

Programme coordinator = Studiengangsbeauftrage/r

Georg-August-Universität Göttingen Module B.Inf.1236: Machine Learning	6 C 4 WLH
Learning outcome, core skills: Students • learn concepts and techniques of machine learning and understand their advantages and disadvantages compared with alternative approaches • learn techniques of supervised learning for classification and regression • learn techniques of unsupervised learning for density estimation, dimensionality reduction and clustering • implement machine learning algorithms like linear regression, logistic regression, kernel methods, tree-based methods, neural networks, principal component analysis, k-means and Gaussian mixture models • solve practical data science problems using machine learning methods	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Machine Learning (Lecture) Bishop: Pattern recognition and machine learning. https://cs.ugoe.de/prml	2 WLH
Examination: Written examination (90 minutes) **Examination prerequisites:** B.Inf.1236.Ex: At least 50% of homework exercises solved and N-1 attempts presented to tutors **Examination requirements:** Knowledge of the working principles, advantages and disadvantages of the machine learning methods covered in the lecture	6 C
Course: Machine Learning - Exercise (Exercise) *Contents*: Students present their solutions of the homework exercises to tutors and discuss them with their tutors.	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Knowledge of basic linear algebra and probability English language proficiency at level B2 (CEFR)
Language: English	**Person responsible for module:** Prof. Dr. Alexander Ecker
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 4
Maximum number of students: 100	

Georg-August-Universität Göttingen **Module B.Inf.1237: Deep Learning for Computer Vision**	6 C 4 WLH

Learning outcome, core skills: Students • learn concepts and techniques of deep learning and understand their advantages and disadvantages compared to alternative approaches • learn to solve practical data science problems using deep learning • implement deep learning techniques like multi-layer perceptrons, convolutional neural networks and other modern deep learning architectures • learn techniques for optimization and regularization of deep neural networks • learn applications of deep neural networks for computer vision tasks such as segmentation and object detection	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Deep Learning for Computer Vision (Lecture) Goodfellow, Bengio, Courville: Deep Learning. https://www.deeplearningbook.org Bishop: Pattern Recognition and Machine Learning. https://cs.ugoe.de/prml	2 WLH
Examination: Written examination (90 minutes) **Examination prerequisites:** B.Inf.1237.Ex: At least 50% of homework exercises solved and N-1 attempts presented to tutors **Examination requirements:** Knowledge of basic deep learning techniques, their advantages and disadvantages and approaches to optimization and regularization. Ability to implement these techniques.	6 C

Course: Deep Learning for Computer Vision - Exercise (Exercise) *Contents*: Students present their solutions of the homework exercises to tutors and discuss them with their tutors.	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of linear algebra and probability Completion of B.Inf.1236 Machine Learning or equivalent
Language: English	**Person responsible for module:** Prof. Dr. Constantin Pape Prof. Dr. Alexander Ecker
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 5
Maximum number of students: 100	

Georg-August-Universität Göttingen Module B.Inf.1240: Visualization	6 C 4 WLH
Learning outcome, core skills: Knowledge of • the potentials and limitations of data visualization • the fundamentals of visual perception and cognition and their implications for data visualization. Students can apply these to the design of visualizations and detect manipulative design choices • a broad variety of techniques for visual representation of data, including abstract and high-dimensional data. Students can select appropriate methods on new problems • integration of visualization into the data analysis process, algorithmic generation and interactive methods	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Visualization (Lecture, Exercise)	4 WLH
Examination: Practical project (2-3 weeks) with presentation and questions during oral exam in groups (approx. 20 minutes per examinee). **Examination prerequisites:** At least 50% of homework exercises solved. **Examination requirements:** Knowledge of potentials and limitations of data visualization, fundamentals of visual perception and their implications for good design choices, techniques for visual representation and how to use them.	6 C

Admission requirements: none	**Recommended previous knowledge:** Foundations of linear algebra and analysis (e.g. B.Mat.0801 and B.Mat.0802) and programming skills (e.g. B.Inf.1842).
Language: English	**Person responsible for module:** Prof. Dr. Bernhard Schmitzer
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 6
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module B.Inf.1241: Computational Optimal Transport**	6 C 4 WLH

Learning outcome, core skills: Knowledge of • the fundamental notions of optimal transport, and its strengths and limitations as a data analysis tool • the discrete Kantorovich formulation, its convex duality, and Wasserstein distances • classical numerical algorithms, entropic regularization, and their scopes of applicability • examples for data analysis applications. Students can transfer these to new potential applications	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Computational Optimal Transport (Lecture, Exercise)	4 WLH
Examination: Written exam (90 minutes) or oral exam (approx. 20 minutes) **Examination prerequisites:** At least 50% of homework exercises solved. **Examination requirements:** Knowledge of Kantorovich duality, Wasserstein distances, standard algorithms and implications for data analysis applications.	6 C

Admission requirements: none	**Recommended previous knowledge:** Foundations of linear algebra and analysis (e.g. B.Mat.0801 and B.Mat.0802) and programming skills (e.g. B.Inf.1842).
Language: English	**Person responsible for module:** Prof. Dr. Bernhard Schmitzer
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 4 - 6
Maximum number of students: 50	

Georg-August-Universität Göttingen **Modul B.Mat.0720: Mathematische Anwendersysteme (Grundlagen)** *English title: Mathematical application software*	3 C 2 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden • die Grundprinzipien der Programmierung erfasst; • die Befähigung zum sicheren Umgang mit einer Programmiersprache im mathematische Kontext erworben; • Erfahrungen mit elementaren Algorithmen und deren Anwendungen gesammelt. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Kenntnisse über eine Programmiersprache im mathematischen Kontext erworben. Sie • haben die Fähigkeit erworben, Algorithmen in einer Programmiersprache umzusetzen; • haben gelernt die Programmiersprache zum Lösen von Algebraischen Problemen zu nutzen (Computeralgebra CAS).	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Blockkurs *Inhalte*: Blockkurs bestehend aus Vorlesung, Übungen und Praktikum, z.B. "Einführung in Python und Computeralgebra".	2 SWS
Prüfung: Klausur (90 Minuten)	3 C
Prüfungsanforderungen: Grundkenntnisse in einer Programmiersprache mit Fokus auf mathematisch orientierte Anwendung und Hintergrund.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0011, B.Mat.0012
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik.

- Ausschluss: Studierende, die das Modul B.Mat.0721 bereits erfolgreich absolviert haben, dürfen das Modul B.Mat.0720 nicht absolvieren.

Georg-August-Universität Göttingen **Modul B.Mat.0721: Mathematisch orientiertes Programmieren** *English title: Mathematics related programming*	6 C 3 SWS

Lernziele/Kompetenzen: **Lernziele:** Das erfolgreiche Absolvieren des Moduls ermöglicht den Studierenden den sicheren Umgang mit mathematischen Anwendersystemen. Die Studierenden • erwerben die Befähigung zum sicheren Umgang mit mathematischen Anwendersystemen, • erfassen die Grundprinzipien der Programmierung, • sammeln Erfahrungen mit elementaren Algorithmen und deren Anwendungen, • verstehen die Grundlagen der Programmierung in einer high-level Programmiersprache, • lernen Kontroll- und Datenstrukturen kennen, • erlernen die Grundzüge des imperativen und funktionalen Programmierens, • setzen Bibliotheken zur Lösung naturwissenschaftlicher Fragestellungen ein, • erlernen verschiedene Methoden der Visualisierung, • beherrschen die Grundtechniken der Projektverwaltung (Versionskontrolle, Arbeiten im Team). **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Techniken für das Lösen mathematisch/physikalischer Problemstellungen mit der Hilfe einer high-level Programmiersprache erlernt.	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

Lehrveranstaltung: Blockkurs *Inhalte*: Blockkurs bestehend aus Vorlesung, Übungen und Praktikum, z.B. "Mathematisch orientiertes Programmieren"	2 SWS
Prüfung: Klausur (90 Minuten) oder mündliche Prüfung (ca. 20 min)	6 C

Prüfungsanforderungen: Nachweis über den Erwerb der folgenden Kenntnisse und Fähigkeiten. Die Teilnehmer/innen weisen grundlegende Techniken für das Lösen mathematisch/physikalischer Problemstellungen mit der Hilfe einer Programmiersprache nach.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0011, B.Mat.0012
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	Bachelor: 1 - 6; Master: 1 - 4
Maximale Studierendenzahl: 120	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0730: Praktikum Wissenschaftliches Rechnen** *English title: Practical course in scientific computing*	9 C 4 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls besitzen die Studierenden praktische Erfahrungen im wissenschaftlichen Rechnen. Sie • erstellen größere Programmierprojekte in Einzel- oder Gruppenarbeit; • erwerben und festigen Programmierkenntnisse; • haben Erfahrungen mit grundlegenden Verfahren zur numerischen Lösung von mathematischen Problemen. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • mathematische Algorithmen und Verfahren in einer Programmiersprache oder einem Anwendersystem zu implementieren; • spezielle numerische Bibliotheken zu nutzen; • komplexe Programmieraufgaben so zu strukturieren, dass sie effizient in Gruppenarbeit bewältigt werden können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 214 Stunden
Lehrveranstaltung: Praktikum Wissenschaftliches Rechnen	4 SWS
Prüfung: Präsentation (ca. 30 Minuten) oder Hausarbeit (max. 50 Seiten ohne Anhänge) **Prüfungsvorleistungen:** Regelmäßige Teilnahme im Praktikum	9 C
Prüfungsanforderungen: • Grundkenntnisse der numerischen Mathematik • gute Programmierkenntnisse	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0721, B.Mat.1300 Kenntnis des objektorientierten Programmierens
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0740: Stochastisches Praktikum** *English title: Practical course in stochastics*	9 C 6 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit den grundlegenden Eigenschaften und Methoden einer stochastischen Simulations- und Analyse-Software (z.B. “R” oder Matlab) vertraut. Sie haben in Projektarbeit Spezialkenntnisse in Stochastik erworben. Sie • implementieren und interpretieren selbstständig einfache stochastische Problemstellungen in einer entsprechenden Software; • schreiben selbständig einfache Progamme in der entsprechenden Software; • beherrschen einige grundlegende Techniken der statistischen Datenanalyse und stochastischen Simulation, wie etwa der deskriptiven Statistik, der linearen, nichtlinearen und logistischen Regression, der Maximum-Likelihood-Schätzmethode, sowie von verschiedenen Testverfahren und Monte-Carlo-Simulationsmethoden. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage • eine stochastische Simulations- und Analyse-Software auf konkrete stochastische Problemstellungen anzuwenden und die erhaltenen Resultate fachgerecht zu präsentieren; • statistische Daten und ihre wichtige Eigenschaften adäquat zu visualisieren und interpretieren.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Stochastisches Praktikum	6 SWS
Prüfung: Präsentation (ca. 45 Minuten) mit schriftlicher Ausarbeitung (max. 50 Seiten ohne Anhänge)	9 C

Prüfungsanforderungen: Weiterführende Kenntnisse in Stochastik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.2410
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Mathematische Stochastik

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.Mat.0910: Linux effektiv nutzen
English title: Effective use of Linux</td><td>3 C (Anteil SK: 3 C)
2 SWS</td></tr>
</table>

<table>
<tr><td>Lernziele/Kompetenzen:
Lernziele:
Das UNIX-Derivat Linux ist mit Abstand das meistgenutzte Betriebssystem, allerdings nicht auf dem Desktop, sondern in Mobiltelefonen, auf Heimgeräten und auf Servern. Auch MAC-Systeme beruhen auf einem UNIX-System. Diese Modul biete eine Einführung in Grundlagen des Systems und der Netzwerkanbindung von Linux. Der Schwerpunkt liegt in der Nutzung von Linux und der Automation von Aufgaben auf der Commandline. Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über fundierte Grundlagenkenntnisse in folgenden Bereichen:
• Linux als Einzelsystem;
• Linux im Netzwerk;
• Automatisierung von Aufgaben mit Shellskripten.
Kompetenzen:
Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage
• wesentlichen Abläufe im Linuxsystem zu verstehen;
• mit einem Mehrbenutzerbetriebssystem auf der Ebene einfacher Systemverwaltung im Einzel- und im Netzwerkbetrieb umzugehen;
• Skripte zur effektiven Aufgabenbewältigung zu erstellen.</td><td>Arbeitsaufwand:
Präsenzzeit:
28 Stunden
Selbststudium:
62 Stunden</td></tr>
</table>

<table>
<tr><td>Lehrveranstaltung: Vorlesung mit integrierten Übungen</td><td>2 SWS</td></tr>
<tr><td>Prüfung: Klausur (90 Minuten), unbenotet
Prüfungsvorleistungen:
B.Mat.0910.Ue: Erreichen von mindestens 50% der Übungspunkte</td><td>3 C</td></tr>
</table>

<table>
<tr><td>Prüfungsanforderungen:
Grundkenntnisse in der Erstellung von Skripten im Einzel- und Netzwerkbetrieb, sicherer Umgang mit und Zuordnung von Begriffen aus einem Mehrbenutzerbetriebssystem im Einzel- und Netzwerkbetrieb.</td><td></td></tr>
</table>

<table>
<tr><td>Zugangsvoraussetzungen:
keine</td><td>Empfohlene Vorkenntnisse:
Sicherer Umgang mit einem Computersystem</td></tr>
<tr><td>Sprache:
Deutsch</td><td>Modulverantwortliche[r]:
Studiendekan*in</td></tr>
<tr><td>Angebotshäufigkeit:
jedes Sommersemester</td><td>Dauer:
1 Semester</td></tr>
<tr><td>Wiederholbarkeit:
zweimalig</td><td>Empfohlenes Fachsemester:
Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6</td></tr>
<tr><td>Maximale Studierendenzahl:
nicht begrenzt</td><td></td></tr>
</table>

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts
- Schlüsselkompetenz im Bereich "EDV/IKT-Kompetenz (IKT=Informations- und Kommunikationstechnologie)", auch für Studierende anderer Fakultäten.

Georg-August-Universität Göttingen **Modul B.Mat.0921: Einführung in TeX/LaTeX und praktische Anwendungen** *English title: Introduction to TeX/LaTeX with applications*	3 C (Anteil SK: 3 C) 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit dem Einsatz von TeX oder LaTeX zur Erstellung von wissenschaftlichen Texten und Vorträgen vertraut. Sie • sind vertraut mit ordentlicher Dokumentengliederung; • erstellen Literaturangaben und Querverweise; • erzeugen mathematische Formeln; • erzeugen Grafiken und binden sie ein. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • einfache Dokumente mit LaTeX zu erstellen; • ansprechende Vortragsfolien mit LaTeX zu erzeugen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Blockkurs *Inhalte*: Einwöchige Blockveranstaltung mit Praktikum	
Prüfung: Hausarbeit (max. 10 Seiten), unbenotet **Prüfungsvorleistungen:** Regelmäßige Teilnahme an der Veranstaltung **Prüfungsanforderungen:** Erstellung eines wissenschaftlichen Portfolios mit TeX/LaTeX und der Folien für eine Präsentation mit Beamer-TeX.	3 C

Prüfungsanforderungen: Sicherer Umgang mit den grundlegenden Funktionen von LaTeX und Bearmer-TeX	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundkenntnisse im Umgang mit einem Computer.
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Mathematischen Instituts

Georg-August-Universität Göttingen **Module B.Mat.0922: Mathematics information services and electronic publishing**	3 C (incl. key comp.: 3 C) 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: After having successfully completed the module, students are familiar with the basics of mathematics information services and electronic publishing. They • work with popular information services in mathematics and with conventional, non-electronic as well as electronic media; • know a broad spectrum of mathematical information sources including classification principles and the role of meta data; • are familiar with current development in the area of electronic publishing in the subject mathematics. **Core skills:** After successfull completion of the module students have acquired subject-specific information competencies. They • have suitable research skills; • are familiar with different information and specific publication services.	Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture) *Contents*: Lecture course with project report	
Examination: Written examination (90 minutes), not graded **Examination prerequisites:** Regular participation in the course	3 C

Examination requirements: Application of the acquired skills in individual projects in the area of mathematical information services and electronic publishing	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dean of studies
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximum number of students: not limited	

Additional notes and regulations:

Instructors: Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.0923: Scientific Writing**	3 C (incl. key comp.: 3 C) 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: After having successfully completed the module, students are familiar with the basics of scientific writing. Objectives: • How to start; motivation for writing a paper (thesis, term paper, seminar presentation, conference talk); choice of language (German/English/?); when to start; support resources. • Different text types in the professional carreer, e.g. motivation letter, research report, technical report, proposal etc. • Plagiarism; different types of plagiarism, unintentional and intentional plagiarism; how to avoid and recognise plagiarism? How to avoid being accused of plagiarism? • Planning and execution, structure, overall style of language, clear and concise writing, writing problems and how to avoid them, cultural sensitivity, cultural transferability. • Discussion; purpose, content, tense, structure; introducing tense, voice and mood; introducing modular writing and why it helps. • Methods; purpose, content (Bishop report implications), tense, structure. • Results; purpose, content, tense, structure; what goes in figures, images and tables; effective placing and citation of figures, images, tables; warning on image manipulation. • Introduction; purpose, content, tense, structure. • Title, abstract, key words, search engine optimization, list of references, acknowledgements. • Optionally, choosing a journal, text matching, predatory & trick journals, your audience, factors affecting choice, scope, impact factors, open access. • Optionally, ethics of publication, COPE, Vancouver rules and other bodies, authorship, author order, contributorship statements, coauthors, corresponding authors, chaperones, grievance procedures. **Core skills:** After successfull completion of the module students have acquired subject-specific competencies in scientific writing. They • have suitable research skills; • are familiar with how to find and discuss a topic academically and using academic terms and methodology.	Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Contents: Lecture course with project report	

Examination: Term Paper (max. 15 pages), not graded	3 C
Examination requirements: Application of the acquired skills in individual projects in the area of mathematical information services and electronic publishing	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dean of studies
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximum number of students: not limited	

Additional notes and regulations: **Instructors:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Modul B.Mat.0931: Tutorentraining** *English title: Coaching of teaching assistants*	4 C (Anteil SK: 4 C) 2 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit theoretischen und praktischen Fragestellungen der Vermittlung mathematischen Wissens vertraut. Sie werden befähigt, • mathematische Inhalte an Studierende im ersten Semester zu vermitteln; • eine heterogene Übungsgruppe zu leiten. • verschiedene Lehrmethoden und Visualisierungstechniken einzusetzen; • souverän aufzutreten. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • Rhetorik- und Präsentationstechniken einzusetzen; • Teamkompetenzen (insb. Motivationsfähigkeit und sicherer Umgang mit Konfliktsituationen) einzusetzen; • Methoden des Zeitmanagements zu verwenden; • interkulturelle Kompetenzen, insbesondere interkulturelle Kommunikationswege einzusetzen.	Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Integratives Projekt	
Inhalte: Neben dem Leiten einer Übungsgruppe während des gesamten Semesters oder einer Blockveranstaltung beinhaltet das Projekt ein Vorbereitungsseminar und ein Abschlussseminar sowie begleitende Kurzveranstaltungen.	
Prüfung: Präsentation [Übungsstunde] (ca. 45 Minuten) und schriftliche Ausarbeitung (max. 5 Seiten), unbenotet **Prüfungsvorleistungen:** Teilnahme an der Veranstaltung	4 C

Prüfungsanforderungen:	
Nachweis des Erreichens der Lernziele und Erwerbs der Kompetenzen durch Umsetzung in einer Übungsstunde	

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
Übertragung der Leitung einer Übungsgruppe zu einer Lehrveranstaltung der Fakultät für Mathematik und Informatik im gleichen Semester	keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit:	**Dauer:**

jedes Wintersemester	1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Mathematischen Instituts

Georg-August-Universität Göttingen **Modul B.Mat.0932: Vermittlung mathematischer Inhalte an ein Fachpublikum** *English title: Communicating mathematical topics to a professional audience*	3 C (Anteil SK: 3 C) 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit theoretischen und praktischen Grundlagen der Vermittlung mathematischen Wissens vertraut. Sie • schätzen das Niveaus der Zielgruppe einer mathematischen Darbietung ein; • strukturieren Präsentationen gut; • beherrschen sicher stilistische und technische Aspekte der Darbietung; • wählen adäquate Hilfsmittel (z.B. zur Visualisierung); • steuern die Diskussion mit dem Publikum. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über je nach Veranstaltung verschiedene Kommunikations- und Vermittlungskompetenzen sowie ggf. Fremdsprachenkompetenzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Veranstaltung mit theoretischem und praktischem Anteil, kann ggf. als Blockveranstaltung angeboten werden oder als Teil eines mathematischen Seminars. (Seminar)	
Prüfung: Präsentation (45 Minuten), unbenotet **Prüfungsvorleistungen:** Teilnahme an der Veranstaltung	3 C

Prüfungsanforderungen: Nachweis des Erreichens der Lernziele durch Anfertigen einer Darbietung zur Vermittlung mathematischer Inhalte (Format der Darbietung je nach Veranstaltung)	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: keine Angabe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen der Lehreinheit Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0935: Historische, museumspädagogische und technische Aspekte für den Aufbau, Erhalt und die Nutzung wissenschaftlicher Modellsammlungen** *English title: Historical, museum-related, and technical aspects of the building-up, the maintenance and the use of scientific collections*	4 C (Anteil SK: 4 C) 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über Kenntnisse des Planens und Gestaltens von Mathematikunterricht und mathematikdidaktischen Forschungsprojekten **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls nutzen die Studierenden Kenntnisse der mathematischen Wissensvermittlung. Sie • ordnen wissenschaftliche Modellsammlungen in ihren historischen Kontext ein, • nutzen museumspädagogische Ansätze für die Vermittlung mit Hilfe von Objekten, • kennen Beispiele für Techniken, die für den Aufbau und Erhalt von Objekten in Modellsammlungen erforderlich sind.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Seminar	2 SWS
Prüfung: Portfolio (max. 5000 Zeichen), unbenotet	4 C

Prüfungsanforderungen: Erarbeitung historischer, museumspädagogischer und technischer Aspekte eines Modells oder mehrerer Modelle in Kontexten von Sammlungen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: keine Angabe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Mathematischen Instituts

Georg-August-Universität Göttingen **Modul B.Mat.0936: Medienbildung zu mathematischen Objekten und Problemen** *English title: Media education for mathematical objects and problems*	4 C (Anteil SK: 4 C) 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über Kenntnisse des Medienunterstützen Lehrens und Lernens zu mathematischen Objekten und Problemen. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls ordnen die Studierenden wissenschaftliche Modellsammlungen in ihren historischen Kontext ein. Sie • nutzen Kenntnisse der Medienbildung zur mathematischen Wissensvermittlung, • vergleichen unterschiedliche Designs für die Illustration mathematischer Objekte und Probleme, • implementieren beispielhaft unterschiedliche medientechnische Realisierungen mathematischer • Objekte.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Seminar	2 SWS
Prüfung: Portfolio (max. 5000 Zeichen), unbenotet	4 C

Prüfungsanforderungen: Erarbeitung medienbezogener Aspekte eines Modells oder mehrerer Modelle in Kontexten von Sammlungen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: keine Angabe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: **Dozent/in:** Lehrpersonen des Mathematischen Instituts

Georg-August-Universität Göttingen **Modul B.Mat.0940: Mathematik in der Welt, in der wir leben** *English title: The mathematical nature of the world we are living in*	3 C (Anteil SK: 3 C) 2 SWS

Lernziele/Kompetenzen:

Lernziele:

Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit der Rolle der Mathematik in unserer Gesellschaft vertraut, wobei die Schwerpunktsetzung je nach Veranstaltung ausgestaltet wird. Die Studierenden

- entwickeln ein stärkeres Bewusstsein für die Rolle der Mathematik in anderen Fachdisziplinen;
- erwerben ein tieferes Verständnis für die Bedeutung der Mathematik für den (technologischen) Fortschritt;
- erkennen die Bedeutung der Mathematik für das Verständnis von Vorgängen und Erscheinungen in der Natur;
- verstehen die Rolle der Mathematik in der Gesellschaft.

Kompetenzen:

Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über verschiedene Kompetenzen, je nach Ausgestaltung der Lehrveranstaltung haben sie

- ihre Befähigung zum Logischen Denken ausgebaut;
- das mathematische Interpretieren von Observationen und Daten in einem außermathematischem Kontext erlernt;
- die Transferfähigkeit von abstraktem Wissen auf reelle Situationen erworben;
- ihre Methodenkompetenz im mathematischen Bereich gestärkt.

Arbeitsaufwand:

Präsenzzeit:

28 Stunden

Selbststudium:

62 Stunden

Lehrveranstaltung: Vorlesung oder Seminar	
Prüfung: Klausur (90 Minuten) oder Hausarbeit (max. 10 Seiten), unbenotet	3 C

Prüfungsanforderungen:

Nachweis des Erreichens der Lernziele durch Anwendung auf ausgewählte Problemstellungen

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jährlich	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen der Lehreinheit Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0950: Mitgliedschaft in der studentischen oder akademischen Selbstverwaltung** *English title: Membership in the student or academic self-government*	3 C (Anteil SK: 3 C) 1 SWS

Lernziele/Kompetenzen: Die Studierenden erwerben zentrale Kompetenzen der Planung, Organisation, Präsentation sowie Grundkenntnisse in der Projektplanung. Sie erwerben Kompetenzen in Rhetorik, in Selbstpräsentation und in freier Rede. Im Praxisteil erlangen die Studierenden vertiefte Kenntnisse in den Bereichen Moderationstechniken, Gesprächsführung sowie Entscheidungs- und Konfliktlösungsverhalten in Gruppen.	**Arbeitsaufwand:** Präsenzzeit: 14 Stunden Selbststudium: 76 Stunden

Lehrveranstaltung: Gremienveranstaltung	
Prüfung: Hausarbeit (max. 5 Seiten), unbenotet	3 C

Prüfungsanforderungen: Die Studierenden erbringen den Nachweis der Befähigung, dass sie Erfahrungen aus der Praxis mit theoretischen Wissen verknüpfen und Methoden der Reflektion anwenden können.	

Zugangsvoraussetzungen: Mitgliedschaft in mindestens einem der folgenden Gremien: 1. Fakultätsrat der Fakultät für Mathematik und Informatik oder eine seiner Kommissionen 2. Senat der Universität oder einer seiner Kommissionen 3. Vorstand des Studentenwerks 4. Vorstand eines Instituts des Bereichs Mathematik	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Studiendekan/in Mathematik oder Studienreferent/in Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0951: Ehrenamtliches Engagement in einem mathematischen Umfeld** *English title: Civic engagement in a mathematical environment*	3 C (Anteil SK: 3 C) 1 SWS

Lernziele/Kompetenzen: Die Studierenden erwerben zentrale Kompetenzen der Planung, Organisation, Präsentation sowie Grundkenntnisse in der Projektplanung. Sie erwerben Kompetenzen in Rhetorik, in Selbstpräsentation und in freier Rede. Im Praxisteil erlangen die Studierenden vertiefte Kenntnisse in mathematischer Wissensvermittlung sowie in mindestens einem der folgenden Bereichen: • Moderationstechniken, • Gesprächsführung • Entscheidungs- und Konfliktlösungsverhalten in Gruppen.	**Arbeitsaufwand:** Präsenzzeit: 14 Stunden Selbststudium: 76 Stunden

Lehrveranstaltung: Projektarbeit	
Prüfung: Portfolio (max. 5 Seiten), unbenotet	3 C

Prüfungsanforderungen: Die Studierenden erbringen den Nachweis der Befähigung, dass sie Erfahrungen aus der Praxis mit theoretischen Wissen verknüpfen und Methoden der Reflektion anwenden können.	

Zugangsvoraussetzungen: Ehrenamtliche Tätigkeit ohne Entgelt oder Aufwandsentschödigung, z.B. 1. bei der Durchführung der Mathematik-Olympiade oder dem Bundeswettbewerb Mathematik 2. Nachhilfe im Rahmen von sozialen Projekten 3. Mathematisches Korrespondenz-Zirkel 4. MatheCamp	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Studiendekan/in Mathematik oder Studienreferent/in Mathematik

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.Mat.0952: Organisation einer mathematischen Veranstaltung
English title: Event management in mathematics</td><td>3 C (Anteil SK: 3 C)
2 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Lernziele:
Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit Problemen, die bei der Organisation einer mathematischen Veranstaltung entstehen, vertraut. Dabei wird die Schwerpunktsetzung je nach dem zu organisierenden Veranstaltungsprojekt ausgestaltet, zu dem die Studierenden einen abgegrenzten, aktiven Beitrag leisten.
Kompetenzen:
Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über verschiedene Kompetenzen, je nach Ausgestaltung des Veranstaltungsprojekts erwerben sie
• Organisations- und Managementkompetenzen;
• Kompetenzen im Informations- und Zeitmanagement;
• Teamkompetenz.</td><td>Arbeitsaufwand:
Präsenzzeit:
28 Stunden
Selbststudium:
62 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Integratives Projekt
Inhalte:

Angebotshäufigkeit: jährlich</td><td></td></tr>
<tr><td>Prüfung: Projektpräsentation (ca. 20 Minuten) oder Hausarbeit (max. 5 Seiten), unbenotet</td><td>3 C</td></tr>
<tr><td>Prüfungsanforderungen:
Nachweis der Kompetenzen und Fähigkeiten durch einen abgegrenzten, aktiven Beitrag zu einem Veranstaltungsprojekt.</td><td></td></tr>
</table>

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: keine Angabe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 1 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:
Dozent/in: Lehrpersonen der Lehreinheit Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0970: Betriebspraktikum** *English title: Internship*	8 C (Anteil SK: 8 C)
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls besitzen die Studierenden Kompetenzen in projektbezogener und forschungsorientierter Teamarbeit sowie im Projektmanagement. Sie sind mit Verfahren, Werkzeugen und Prozessen der Mathematik sowie dem organisatorischen und sozialen Umfeld der Praxis vertraut.	**Arbeitsaufwand:** Präsenzzeit: 0 Stunden Selbststudium: 240 Stunden
Lehrveranstaltung: Prüfungskolloquium (Kolloquium)	
Prüfung: Präsentation (ca. 20 Minuten) mit schriftlicher Ausarbeitung (max. 10 Seiten), unbenotet **Prüfungsvorleistungen:** Bescheinigung über die erfolgreiche Erfüllung der gestellten Aufgaben gemäß Praktikumsplan	8 C
Prüfungsanforderungen: Erfolgreiche Bearbeitung der gestellten Aufgaben gemäß zwischen dem oder der Studierenden, der Lehrperson und dem Betrieb zu vereinbarendem Praktikumsplan	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4; Promotion: 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:
Dozent/in: Lehrpersonen der Lehreinheit Mathematik

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.Mat.1400: Maß- und Wahrscheinlichkeitstheorie
English title: Measure and probability theory</td><td>9 C
6 SWS</td></tr>
</table>

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Lernziele/Kompetenzen:

Lernziele:

Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit den Grundbegriffen und Methoden der Maßtheorie sowie auch der Wahrscheinlichkeitstheorie vertraut, die die Grundlage des Schwerpunkts "Mathematische Stochastik" bilden. Sie

- kennen die wichtigsten elementaren stochastischen Grundmodelle und Verteilungen von Zufallsvariablen;
- verstehen grundlegende Eigenschaften sowie Existenz und Eindeutigkeitsaussagen von Maßen;
- gehen sicher mit allgemeinen Maß-Integralen um, insbesondere mit dem Lebesgue-Integral;
- kennen sich mit Lp-Räumen und Produkträumen aus;
- formulieren wahrscheinlichkeitstheoretische Aussagen mit Wahrscheinlichkeitsräumen, Wahrscheinlichkeitsmaßen und Zufallsvariablen;
- rechnen und modellieren mit stetigen und mehrdimensionalenVerteilungen;
- beschreiben Wahrscheinlichkeitsmaße mit Hilfe von Verteilungsfunktionen bzw. Dichten;
- verstehen und nutzen das Konzept der Unabhängigkeit;
- berechnen Erwartungswerte von Funktionen von Zufallsvariablen;
- verstehen die verschiedenen stochastischen Konvergenzbegriffe und ihre Beziehungen;
- kennen charakteristische Funktionen und deren Anwendungen;
- besitzen Grundkenntnisse über bedingte Wahrscheinlichkeiten und bedingte Erwartungswerte;
- verwenden und beweisen das schwache Gesetz der großen Zahlen und den zentralen Grenzwertsatz;
- kennen einfache stochastische Prozesse wie z.B. Markov-Ketten.

Kompetenzen:

Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Kompetenzen im Schwerpunkt "Mathematische Stochastik" erworben. Sie sind in der Lage,

- Maßräume und Maß-Integrale anzuwenden;
- stochastische Denkweisen einzusetzen und einfache stochastische Modelle zu formulieren;
- stochastische Modelle mathematisch zu analysieren;
- die wichtigsten Verteilungen zu verstehen und anzuwenden;
- stochastische Abschätzungen mit Hilfe von Wahrscheinlichkeitsgesetzen durchzuführen;

</td><td>

Arbeitsaufwand:

Präsenzzeit:

84 Stunden

Selbststudium:

186 Stunden

</td></tr>
</table>

• grundlegende Grenzwertsätze der Wahrscheinlichkeitstheorie zu verwenden und zu beweisen.	

Lehrveranstaltung: Maß- und Wahrscheinlichkeitstheorie (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.1400.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Lehrveranstaltung: Maß- und Wahrscheinlichkeitstheorie - Übung (Übung)	2 SWS

Prüfungsanforderungen: Nachweis von Grundkenntnissen in diskreter Stochastik sowie Maß- und Wahrscheinlichkeitstheorie	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 5
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent*in: Lehrpersonen des Instituts für Mathematische Stochastik

Georg-August-Universität Göttingen **Modul B.Mat.2100: Partielle Differenzialgleichungen** *English title: Partial differential equations*	9 C 6 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit grundlegenden Typen von Differenzialgleichungen und Eigenschaften ihrer Lösungen vertraut. Sie • beschreiben grundlegende Eigenschaften von Lösungen der Laplace-, Wärmeleitungs- und Wellengleichung und zugehöriger Rand- bzw. Anfangs-Randwertprobleme; • sind mit grundlegenden Eigenschaften von Fourier-Transformation und Sobolev-Räumen auf beschränkten und unbeschränkten Gebieten vertraut; • analysieren die Lösbarkeit von Randwertproblemen für elliptische Differenzialgleichungen mit variablen Koeffizienten; • analysieren die Regularität von Lösungen elliptischer Randwertprobleme im Inneren und am Rand. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • den Typ einer partiellen Differenzialgleichung zu erkennen und auf qualitative Eigenschaften ihrer Lösungen zu schließen; • mathematisch relevante Fragestellungen zu partiellen Differenzialgleichungen zu erkennen; • den Einfluss von Randbedingungen und Funktionenräumen auf Existenz, Eindeutigkeit und Stabilität von Lösungen zu beurteilen.	Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Partielle Differenzialgleichungen (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2100.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Lehrveranstaltung: Partielle Differenzialgleichungen - Übung (Übung)	2 SWS

Prüfungsanforderungen: Nachweis der Grundkenntnisse über partielle Differenzialgleichungen	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: zweijährig jeweils im Wintersemester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts oder des Instituts für Numerische und Angewandte Mathematik
- Ausschlüsse: Dieses Modul darf nicht in dem Studiengang "Master of Education", Fach Mathematik, eingebracht werden, wenn im Bachelor-Studium bereits eines der nachstehenden Module eingebracht wurde:
  - B.Mat.1100 „Analysis auf Mannigfaltigkeiten“
  - B.Mat.2110 „Funktionalanalysis“
  - B.Mat.2120 „Funktionentheorie“
  - B.Mat.2100 „Partielle Differenzialgleichungen“
  - B.Mat.0030 „Gewöhnliche Differenzialgleichungen“

Georg-August-Universität Göttingen **Modul B.Mat.2110: Funktionalanalysis** *English title: Functional analysis*	9 C 6 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit funktionalanalytischer Denkweise und den zentralen Resultaten aus diesem Gebiet vertraut. Sie • gehen sicher mit den gängigsten Beispielen von Funktionen- und Folgenräumen wie Lp, lp und Räumen stetiger Funktionen um und analysieren deren funktionalanalytische Eigenschaften; • wenden die grundlegenden Sätze über lineare Operatoren in Banach-Räumen an, insbesondere die Sätze von Banach-Steinhaus, Hahn-Banach und den Satz über die offene Abbildung; • argumentieren mit schwachen Konvergenzbegriffen und den grundlegenden Eigenschaften von Dual- und Bidualräumen; • erkennen Kompaktheit von Operatoren und analysieren die Lösbarkeit linearer Operatorgleichungen mit Hilfe der Riesz-Fredholm-Theorie; • sind mit grundlegenden Begriffen der Spektraltheorie und dem Spektralsatz für beschränkte, selbstadjungierte Operatoren vertraut. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • in unendlich-dimensionalen Räumen geometrisch zu argumentieren; • Aufgabenstellungen in funktionalanalytischer Sprache zu formulieren und zu analysieren; • die Relevanz funktionalanalytischer Eigenschaften wie der Wahl eines passenden Funktionenraums, Vollständigkeit, Beschränktheit oder Kompaktheit zu erkennen und zu beschreiben.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden
Lehrveranstaltung: Funktionalanalysis (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2110.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C
Lehrveranstaltung: Funktionalanalysis - Übung (Übung)	2 SWS
Prüfungsanforderungen: Nachweis der Grundkenntnisse über Funktionalanalysis	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache:	**Modulverantwortliche[r]:**

Englisch, Deutsch	Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts oder des Instituts für Numerische und Angewandte Mathematik
- Ausschlüsse: Dieses Modul darf nicht in dem Studiengang "Master of Education", Fach Mathematik, eingebracht werden, wenn im Bachelor-Studium bereits eines der nachstehenden Module eingebracht wurde:
  - B.Mat.1100 „Analysis auf Mannigfaltigkeiten“
  - B.Mat.2110 „Funktionalanalysis“
  - B.Mat.2120 „Funktionentheorie“
  - B.Mat.2100 „Partielle Differenzialgleichungen“
  - B.Mat.0030 „Gewöhnliche Differenzialgleichungen“

Georg-August-Universität Göttingen **Modul B.Mat.2120: Funktionentheorie** *English title: Complex analysis*	9 C 6 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit Grundbegriffen und Methoden der komplexen Analysis vertraut. Sie • gehen sicher mit dem Holomorphiebegriff um und kennen gängige Beispiele von holomorphen Funktionen; • beherrschen insbesondere die verschiedenen Definitionen für Holomorphie und erkennen deren Äquivalenz; • verstehen den Cauchyschen Intergralsatz und den Residuensatz und wenden diese Sätze innerhalb der Funktionentheorie an; • erarbeiten weitere ausgewählte Themen der Funktionentheorie; • erlernen und vertiefen funktionentheoretische Herangehensweisen an mathematische Problemstellungen an Hand ausgewählter Beispiele. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • sicher mit grundlegenden Methoden und Grundbegriffen aus der Funktionentheorie umzugehen; • auf Basis funktionentheoretischer Denkweisen und Beweistechniken zu argumentieren; • sich in verschiedene Fragestellungen im Bereich "Funktionentheorie" einzuarbeiten; • funktionentheoretische Methoden auf weiterführende Themen aus der Funktionentheorie und verwandten Gebieten anzuwenden.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Funktionentheorie (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2120.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Lehrveranstaltung: Funktionentheorie - Übung (Übung)	2 SWS

Prüfungsanforderungen: Nachweis der Grundkenntnisse in Funktionentheorie	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit:	**Dauer:**

jedes Sommersemester	1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts
- Ausschlüsse: Dieses Modul darf nicht in dem Studiengang "Master of Education", Fach Mathematik, eingebracht werden, wenn im Bachelor-Studium bereits eines der nachstehenden Module eingebracht wurde:
  - B.Mat.1100 „Analysis auf Mannigfaltigkeiten“
  - B.Mat.2110 „Funktionalanalysis“
  - B.Mat.2120 „Funktionentheorie“
  - B.Mat.2100 „Partielle Differenzialgleichungen“
  - B.Mat.0030 „Gewöhnliche Differenzialgleichungen“

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.Mat.2200: Moderne Geometrie
English title: Modern geometry</td><td>9 C
6 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Lernziele:
Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit Methoden und Konzepten der modernen Geometrie vertraut. Abhängig vom weiterführenden Angebot stehen Methoden der elementaren Differenzialgeometrie oder grundlegende Konzepte der algebraischen Geometrie im Mittelpunkt. Die Studierenden
• kennen die Grundlagen der Differenzialgeometrie von Kurven und Flächen;
• sind mit den inneren Eigenschaften von Flächen vertraut;
• lernen einfache globale Ergebnisse kennen;
oder sie
• kennen grundlegende Konzepte der algebraischen Geometrie in wichtigen Beispielen;
• sind mit der Formulierung geometrischer Fragen in der Sprache der Algebra vertraut;
• arbeiten mit zentralen Begriffen und Ergebnissen der kommutativen Algebra.
Kompetenzen:
Nach erfolgreichem Absolvieren dieses Moduls verfügen die Studierenden über grundlegende Kompetenzen in der modernen Geometrie und sind auf weiterführende Veranstaltungen in der Differenzialgeometrie oder in der algebraischen Geometrie vorbereitet. Sie sind in der Lage,
• geometrische Fragestellungen mit Konzepten der Differenzialgeometrie oder der algebraischen Geometrie zu präzisieren;
• Probleme anhand von Ergebnissen der Differenzialgeometrie oder der algebraischen Geometrie zu lösen;
• mit Fragestellungen und Anwendungen des jeweiligen Gebiets umzugehen.</td><td>Arbeitsaufwand:
Präsenzzeit:
84 Stunden
Selbststudium:
186 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Vorlesung (Vorlesung)</td><td>4 SWS</td></tr>
<tr><td>Prüfung: Klausur (120 Minuten)
Prüfungsvorleistungen:
B.Mat.2200.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen</td><td>9 C</td></tr>
<tr><td>Lehrveranstaltung: Übung
Angebotshäufigkeit: jedes Wintersemester</td><td>2 SWS</td></tr>
<tr><td>Prüfungsanforderungen:
Nachweis der Grundkenntnisse über Geometrie</td><td></td></tr>
</table>

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	B.Mat.0021, B.Mat.0022

Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Mathematischen Instituts

Georg-August-Universität Göttingen **Modul B.Mat.2210: Zahlen und Zahlentheorie** *English title: Numbers and number theory*	9 C 6 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit Grundbegriffen und Methoden der elementaren Zahlentheorie vertraut. Sie • erwerben grundlegende Kenntnisse über Zahlentheorie; • sind insbesondere mit Teilbarkeit, Kongruenzen, arithmetischen Funktionen, Reziprozitätsgesetz, elementaren diophantischen Gleichungen vertraut; • kennen die elementare Theorie p-adischer Zahlen; • sind mit weiteren ausgewählten Themen der Zahlentheorie vertraut. **Kompetenzen**: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • elementare zahlentheoretische Denkweisen und Beweistechniken zu beherrschen; • mit Grundbegriffen und grundlegenden Methoden der Zahlentheorie zu argumentieren; • mit Begriffen und Methoden aus weiterführenden Themen der Zahlentheorie zu arbeiten.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Zahlen und Zahlentheorie (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2210.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Lehrveranstaltung: Zahlen und Zahlentheorie - Übung (Übung)	2 SWS

Prüfungsanforderungen: Nachweis der Grundkenntnisse der Zahlentheorie	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Mathematischen Instituts
- Ausschlüsse: Dieses Modul darf nicht in dem Studiengang "Master of Education", Fach Mathematik, eingebracht werden, wenn im Bachelor-Studium bereits eines der nachstehenden Module eingebracht wurde:
  - B.Mat.1200 „Algebra“
  - B.Mat.2210 „Zahlen und Zahlentheorie“
  - B.Mat.2220 „Diskrete Mathematik“

Georg-August-Universität Göttingen **Modul B.Mat.2300: Numerische Analysis** *English title: Numerical analysis*	9 C 6 SWS

Lernziele/Kompetenzen: Lernziele: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit weiterführenden Begriffen und Methoden im Schwerpunkt "Numerische und angewandte Mathematik" vertraut. Sie • interpolieren vorgegebene Stützpunkte mit Hilfe von Polynomen, trigonometrischen Polynomen und Splines; • integrieren Funktionen numerisch mit Hilfe von Newton-Cotes Formeln, Gauß-Quadratur und Romberg-Quadratur; • modellieren Evolutionsprobleme mit Anfangswertaufgaben für Systeme von gewöhnlichen Differenzialgleichungen, lösen diese numerisch mit Runge-Kutta-Verfahren und analysieren deren Konvergenz; • erkennen die Steifheit von gewöhnlichen Differenzialgleichungen und lösen entsprechende Anfangswertprobleme mit impliziten Runge-Kutta-Verfahren; • lösen je nach Ausrichtung der Veranstaltung Randwertprobleme oder sind mit Computer Aided Graphic Design (CAGD), Grundlagen der Approximationstheorie oder anderen Gebieten der Numerischen Mathematik vertraut. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage • Algorithmen zur Lösung mathematischer Probleme zu entwickeln und • deren Stabilität, Fehlerverhalten und Komplexität abzuschätzen.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Numerische Mathematik II	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2300.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Lehrveranstaltung: Numerische Mathematik II - Übung	2 SWS

Prüfungsanforderungen: Nachweis weiterführender Kenntnisse in numerischer Mathematik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.1300
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.2310: Optimierung** *English title: Optimisation*	9 C 6 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit Grundbegriffen und Methoden der Optimierung vertraut. Sie • lösen lineare Optimierungsprobleme mit dem Simplex-Verfahren und sind mit der Dualitätstheorie der linearen Optimierung vertraut; • beurteilen Konvergenzeigenschaften und Rechenaufwand von grundlegenden Verfahren für unrestringierte Optimierungsprobleme wie Gradienten- und (Quasi-)Newton-Verfahren; • kennen Lösungsverfahren für nichtlineare, restringierte Optimierungsprobleme und gehen sicher mit den KKT-Bedingungen um; • modellieren Netzwerkflussprobleme und andere Aufgaben als ganzzahlige Optimierungsprobleme und erkennen totale Unimodularität. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, • Optimierungsaufgaben in der Praxis zu erkennen und als mathematische Programme zu modellieren sowie • geeignete Lösungsverfahren zu erkennen und zu entwickeln.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Übungen *Angebotshäufigkeit:* jedes Wintersemester	2 SWS

Lehrveranstaltung: Vorlesung (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2310.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Prüfungsanforderungen: Nachweis der Grundkenntnisse der Optimierung	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6

Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik
- Universitätsweites Schlüsselkompetenzangebot; als solches nicht verwendbar für Studierende im Zwei-Fächer-Bachelor Studiengang mit Fach Mathematik, Studiengang Master of Education mit Fach Mathematik, Bachelor/Master-Studiengang Mathematik und Promotionsstudiengang Mathematical Sciences.

Georg-August-Universität Göttingen Module B.Mat.3041: Overview on non-life insurance mathematics	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: After completion of the module students are familiar with basic notions and methods of non-life insurance mathematics. They • are familiar with basic definitions and terms within non-life insurance mathematics; • understand central aspects of risk theory; • know substantial pricing and reserving methods; • estimate ruin probabilities. **Core skills:** After successful completion of the module students have acquired basic competencies within non-life insurance. They are able to • apply a basic inventory of solving approaches; • analyse and develop pricing models which mathematically are state of the art; • evaluate and quantify fundamental risks.	Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Written examination (120 minutes)	3 C

Examination requirements: Basic knowledge on non-life insurance mathematics	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module B.Mat.3042: Overview on life insurance mathematics	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** After successfully completing this module students are familiar with basic notions and methods of life insurance mathematics. In particular they • master fundamental terms and notions of life insurance mathematics; • know about risk theory and risk management; • know substantial pricing and reserving methods, in particular in health insurance; • know about legal requirements of life, health and pension insurance in Germany. **Core skills:** After successful completion of the module students have acquired basic competencies within life insurance mathematics. The student should be able to • apply a basic inventory of solving approaches; • calculate premiums and provisions in life, health and pension insurance; • evaluate and quantify fundamental risks.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Written examination (120 minutes)	3 C

Examination requirements: Basic knowledge on life insurance mathematics	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers of the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module B.Mat.3043: Non-life insurance mathematics	6 C 4 WLH

Learning outcome, core skills: Non-life insurance mathematics deals with models and methods of quantifying risks with both, the occurrence of the loss and its amount showing random patterns. In particular the following problems are to be solved: • determing appropriate insurance premiums; • calculate adequate loss reserves; • determine how to allocate risk between policyholder and insurer resp. insurer and reinsurers. The German Actuarial Association (Deutsche Aktuarvereinigung e. V.) has certified this module as element of the training as an actuary („Aktuar DAV“ / „Aktuarin DAV“, cf. www.aktuar.de). To this end, the course is designed in view of current legislative and regulatory provisions of the Federal Republic of Germany. **Learning outcome:** The aim of the module is to equip students with knowledge in four areas: 1. risk models; 2. pricing; 3. reserving; 4. risk sharing. After having successfully completed the module, students are familiar with fundamental terms and methods of non-life insurance mathematics. They • are familiar with and able to handle essential definitions and terms within non-life insurance mathematics; • have an overview of the most valuable problem statements of non-life insurance; • understand central aspects of risk theory; • know substantial pricing and reserving methods; • estimate ruin probabilities; • are acquainted with most important reinsurance forms and reinsurance pricing methods. **Core skills:** After having successfully completed the module, students have acquired fundamental competencies within non-life insurance. They are able to • evaluate and quantify fundamental risks; • model the aggregate loss with individual or collective model; • apply a basic inventory of solving approaches; • analyse and develop pricing models which mathematically are state of the art; • apply different reserving methods and calculate outstanding losses; • assess reinsurance contracts.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture course with exercise session	4 WLH

Examination: Written examination (120 minutes)	6 C
Examination requirements: Fundamental knowledge of non-life insurance mathematics	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations:

Instructor: External lecturers at the Institute of Mathematical Stochastics

Accreditation: By the German Actuarial Association (Deutsche Aktuarvereinigung e. V.), valid until winter semester 2017/18

Georg-August-Universität Göttingen Module B.Mat.3044: Life insurance mathematics	6 C 4 WLH

Learning outcome, core skills: This module deals with the basics of different branches in life insurance mathematics. In particular, students get to know both the classical deterministic model and the stochastic model as well as how to apply them to problems relevant in the respective branch. On this base the students describe • essential notions of present values; • premiums and their present values; • the actuarial reserve. The German Actuarial Association (Deutsche Aktuarvereinigung e. V.) has certified this module as element of the training as an actuary („Aktuar DAV“ / „Aktuarin DAV“, cf. www.aktuar.de). To this end, the course is designed in view of current legislative and regulatory provisions of the Federal Republic of Germany. **Learning outcome:** After having successfully completed the module, students are familiar with fundamental terms and methods of life insurance mathematics. In particular they • assess cashflows in terms of financial and insurance mathematics; • apply methods of life insurance mathematics to problems from theory and practise; • characterise financial securities and insurance contracts in terms of cashflows; • have an overview of the most valuable problem statements of life insurance; • understand the stochastic interest structure; • master fundamental terms and notions of life insurance mathematics; • get an overwiew of most important problems in life insurance mathematics; • understand mortality tables and leaving orders within pension insurance; • know substantial pricing and reserving methods; • know the economic and legal requirements of private health insurance in Germany; • are acquainted with per-head loss statistics, present value factor calculation and biometric accounting principles. **Core skills:** After having successfully completed the module, students have acquired fundamental competencies within life insurance. They are able to • assess cashflows with respect to both collateral and risk under deterministic interest structure; • calculate premiums and provisions in life-, health- and pension-insurance; • understand the actuarial equivalence principle as base of actuarial valuation in life insurance; • apply and understand the actuarial equivalence principle for calculating premiums, actuarial reserves and ageing provisions; • calculate profit participation in life insurance; • master premium calculation in health insurance;	**Workload:** Attendance time: 56 h Self-study time: 124 h

• calculate present value and settlement value of pension obligations; • find mathematical solutions to practical questions in life, health and pension insurance.	

Course: Lecture course with exercises	4 WLH
Examination: Written examination (120 minutes)	6 C

Examination requirements: Fundamental knowledge of life insurance mathematics	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations:

Instructor: External lecturers at the Institute of Mathematical Stochastics

Accreditation: By the German Actuarial Association (Deutsche Aktuarvereinigung e. V.), valid until summer semester 2019

Georg-August-Universität Göttingen Module B.Mat.3111: Introduction to analytic number theory	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Analytic number theory" enables students to learn methods, concepts, theories and applications in the area of "Analytic number theory". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • solve arithmetical problems with basic, complex-analytical, and Fourier-analytical methods; • know characteristics of the Riemann zeta function and more general L-functions, and apply them to problems of number theory; • are familiar with results and methods of prime number theory; • acquire knowledge in arithmetical and analytical theory of automorphic forms, and its application in number theory; • know basic sieving methods and apply them to the problems of number theory; • know techniques used to estimate the sum of the sum of characters and of exponentials; • analyse the distribution of rational points on suitable algebraic varieties using analytical techniques; • master computation with asymptotic formulas, asymptotic analysis, and asymptotic equipartition in number theory. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Analytical number theory"; • explain basic ideas of proof in the area "Analytical number theory"; • illustrate typical applications in the area "Analytical number theory".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3111.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Analytic number theory"	

Admission requirements: none	Recommended previous knowledge: B.Mat.1100, B.Mat.1200
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations:
Instructor: Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.3112: Introduction to analysis of partial differential equations**	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Analysis of partial differential equations" enables students to learn methods, concepts, theories and applications in the area "Analysis of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important types of partial differential equations and know their solutions; • master the Fourier transform and other techniques of the harmonic analysis to analyse partial differential equations; • are familiar with the theory of generalized functions and the theory of function spaces and use these for solving differential partial equations; • apply the basic principles of functional analysis to the solution of partial different equations; • use different theorems of function theory for solving partial different equations; • master different asymptotic techniques to study characteristics of the solutions of partial different equations; • are paradigmatically familiar with broader application areas of linear theory of partial different equations; • are paradigmatically familiar with broader application areas of non-linear theory of partial different equations; • know the importance of partial different equations in the modelling in natural and engineering sciences; • master some advanced application areas like parts of microlocal analysis or parts of algebraic analysis. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Analysis of partial different equations"; • explain basic ideas of proof in the area "Analysis of partial different equations"; • illustrate typical applications in the area "Analysis of partial different equations".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3112.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Analysis of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1100, B.Mat.1200
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.3113: Introduction to differential geometry**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Differential geometry" enables students to learn methods, concepts, theories and applications in the area "Differential geometry". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master the basic concepts of differential geometry; • develop a spatial sense using the examples of curves, areas and hypersurfaces; • develop an understanding of the basic concepts of differential geometry like "space" and "manifolds", "symmetry" and "Lie group", "local structures" and "curvature", "global structure" and "invariants" as well as "integrability"; • master (variably weighted and sorted depending on the current courses offered) the theory of transformation groups and symmetries as well as the analysis on manifolds, the theory of manifolds with geometric structures, complex differential geometry, gauge field theory and their applications as well as the elliptical differential equations of geometry and gauge field theory; • develop an understanding for geometrical constructs, spatial patterns and the interaction of algebraic, geometrical, analytical and topological methods; • acquire the skill to apply methods of analysis, algebra and topology for the treatment of geometrical problems; • are able to import geometrical problems to a broader mathematical and physical context. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Differential geometry"; • explain basic ideas of proof in the area "Differential geometry"; • illustrate typical applications in the area "Differential geometry".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3113.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements:	

Proof of knowledge and mastery of basic competencies in the area "Differential geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1100, B.Mat.1200
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

<table>
<tr><td>Georg-August-Universität Göttingen
Module B.Mat.3114: Introduction to algebraic topology</td><td>9 C
6 WLH</td></tr>
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Learning outcome, core skills:
Learning outcome:

In the modules of the cycle "Algebraic topology" students get to know the most important classes of topological spaces as well as algebraic and analytical tools for studying these spaces and the mappings between them. The students use these tools in geometry, mathematical physics, algebra and group theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis.

Algebraic topology uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic topology and supplement one another complementarily. The following content-related competencies are pursued. Students

- know the basic concepts of set-theoretic topology and continuous mappings;
- construct new topologies from given topologies;
- know special classes of topological spaces and their special characteristics like CW complexes, simplicial complexes and manifolds;
- apply basic concepts of category theory to topological spaces;
- use concepts of functors to obtain algebraic invariants of topological spaces and mappings;
- know the fundamental group and the covering theory as well as the basic methods for the computation of fundamental groups and mappings between them;
- know homology and cohomology, calculate those for important examples and with the aid of these deduce non-existence of mappings as well as fixed-point theorems;
- calculate homology and cohomology with the aid of chain complexes;
- deduce algebraic characteristics of homology and cohomology with the aid of homological algebra;
- become acquainted with connections between analysis and topology;
- apply algebraic structures to deduce special global characteristics of the cohomology of a local structure of manifolds.

Core skills:

After having successfully completed the module, students will be able to

- discuss basic concepts of the area "Algebraic topology";
- explain basic ideas of proof in the area "Algebraic topology";
- illustrate typical applications in the area "Algebraic topology".

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Workload:
Attendance time:
84 h
Self-study time:
186 h

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<table>
<tr><td>Course: Lecture course (Lecture)</td><td>4 WLH</td></tr>
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Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3114.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Algebraic topology"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1100, B.Mat.1200
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.3115: Introduction to mathematical methods in physics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Mathematical methods of physics" students get to know different mathematical methods and techniques that play a role in modern physics. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. The topics of the cycle can be divided into four blocks, a cycle normally contains parts of different blocks, that topically supplement each other, but can also be read within one block. The introducing parts of the cycle form the basis for the advanced specialisation area. The topic blocks are • harmonic analysis, algebraic structures and representation theory, (group) effects; • operator algebra, C* algebra and von-Neumann algebra; • operator theory, perturbation and scattering theory, special PDE, microlocal analysis, distributions; • (semi) Riemannian geometry, symplectic and Poisson geometry, quantization. One of the aims is that a connection to physical problems is visible, at least in the motivation of the covered topics. Preferably, in the advanced part of the cycle, the students should know and be able to carry out practical applications themselves. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Mathematical methods of physics"; • explain basic ideas of proof in the area "Mathematical methods of physics"; • illustrate typical applications in the area "Mathematical methods of physics".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3115.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Mathematical methods in physics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1100, B.Mat.1200

Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.3121: Introduction to algebraic geometry**	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

In the modules of the cycle "Algebraic geometry" students get to know the most important classes of algebraic varieties and schemes as well as the tools for studying these objects and the mappings between them. The students apply these skills to problems of arithmetic or complex analysis. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis.

Algebraic geometry uses and connects concepts of algebra and geometry and can be used versatilely. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic geometry and supplement one another complementarily. The following content-related competencies are pursued. Students

- are familiar with commutative algebra, also in greater detail;
- know the concepts of algebraic geometry, especially varieties, schemes, sheafs, bundles;
- examine important examples like elliptic curves, Abelian varieties or algebraic groups;
- use divisors for classification questions;
- study algebraic curves;
- prove the Riemann-Roch theorem and apply it;
- use cohomological concepts and know the basics of Hodge theory;
- apply methods of algebraic geometry to arithmetical questions and obtain e. g. finiteness principles for rational points;
- classify singularities and know the significant aspects of the dimension theory of commutative algebra and algebraic geometry;
- get to know connections to complex analysis and to complex geometry.

Core skills:

After having successfully completed the module, students will be able to

- discuss basic concepts of the area "Algebraic geometry";
- explain basic ideas of proof in the area "Algebraic geometry";
- illustrate typical applications in the area "Algebraic geometry".

Workload:
Attendance time:
84 h
Self-study time:
186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3121.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Algebraic geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1100, B.Mat.1200
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module B.Mat.3122: Introduction to algebraic number theory	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Algebraic number theory" enables students to learn methods, concepts, theories and applications in the areas "Algebraic number theory" and "Algorithmic number theory". During the course of the cycle students will be successively introduced to current theoretical and/or applied research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued in relation to algebra. Students

- know Noetherian and Dedekind rings and the class groups;
- are familiar with discriminants, differents and bifurcation theory of Hilbert;
- know geometrical number theory with applications to the unit theorem and the finiteness of class groups as well as the algorithmic aspects of lattice theory (LLL);
- are familiar with L-series and zeta functions and discuss the algebraic meaning of their residues;
- know densities, the Tchebotarew theorem and applications;
- work with orders, S-integers and S-units;
- know the class field theory of Hilbert, Takagi and Idele theoretical field theory;
- are familiar with Zp-extensions and their Iwasawa theory;
- discuss the most important hypotheses of Iwasawa theory and their consequences.

Concerning algorithmic aspects of number theory, the following competencies are pursued. Students

- work with algorithms for the identification of short lattice bases, nearest points in lattices and the shortest vectors;
- are familiar with basic algorithms of number theory in long arithmetic like GCD, fast number and polynomial arithmetic, interpolation and evaluation and prime number tests;
- use the sieving method for factorisation and calculation of discrete logarithms in finite fields of great characteristics;
- discuss algorithms for the calculation of the zeta function of elliptic curves and Abelian varieties of finite fields;
- calculate class groups and fundamental units;
- calculate Galois groups of absolute number fields.

Core skills:

After having successfully completed the module, students will be able to

- discuss basic concepts of the area "Algebraic number theory";
- explain basic ideas of proof in the area "Algebraic number theory";
- illustrate typical applications in the area "Algebraic number theory".

Workload:

Attendance time:
84 h
Self-study time:
186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3122.Ue:Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Algebraic number theory"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1100, B.Mat.1200
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module B.Mat.3123: Introduction to algebraic structures	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic structures" students get to know different algebraic structures, amongst others Lie algebras, Lie groups, analytical groups, associative algebras as well as the tools from algebra, geometry and category theory that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic structures use concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic structures and supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts like rings, modules, algebras and Lie algebras; • know important examples of Lie algebras and algebras; • know special classes of Lie groups and their special characteristics; • know classification theorems for finite-dimensional algebras; • apply basic concepts of category theory to algebras and modules; • know group actions and their basic classifications; • apply the enveloping algebra of Lie algebras; • apply ring and module theory to basic constructs of algebraic geometry; • use combinatorial tools for the study of associative algebras and Lie algebras; • acquire solid knowledge of the representation theory of Lie algebras, finite groups and compact Lie groups as well as the representation theory of semisimple Lie groups; • know Hopf algebras as well as their deformation and representation theory. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Algebraic structures"; • explain basic ideas of proof in the area "Algebraic structures"; • illustrate typical applications in the area "Algebraic structures".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3123.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Algebraic structures"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1100, B.Mat.1200
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations:
Instructor: Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.3124: Introduction to groups, geometry and dynamical systems**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Groups, geometry and dynamical systems" students get to know the most important classes of groups as well as the algebraic, geometrical and analytical tools that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Group theory uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of the area "Groups, geometry and dynamical systems" that supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts of groups and group homomorphisms; • know important examples of groups; • know special classes of groups and their special characteristics; • apply basic concepts of category theory to groups and define spaces via universal properties; • apply the concepts of functors to obtain algebraic invariants; • know group actions and their basic classification results; • know the basics of group cohomology and compute these for important examples; • know the basics of geometrical group theory like growth characteristics; • know self-similar groups, their basic constructs as well as examples with interesting characteristics; • use geometrical and combinatorial tools for the study of groups; • know the basics of the representation theory of compact Lie groups. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Groups, geometry and dynamical systems"; • explain basic ideas of proof in the area "Groups, geometry and dynamical systems"; • illustrate typical applications in the area "Groups, geometry and dynamical systems".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes)	9 C

Examination prerequisites: B.Mat.3124.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Groups, geometry and dynamical systems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1100, B.Mat.1200
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module B.Mat.3125: Introduction to non-commutative geometry	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

In the modules of the cycle "Non-commutative geometry" students get to know the conception of space of non-commutative geometry and some of its applications in geometry, topology, mathematical physics, the theory of dynamical systems and number theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis.

Non-commutative geometry uses concepts of analysis, algebra, geometry and mathematical physics and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of non-commutative geometry that supplement one another complementarily. The following content-related competencies are pursued. Students

- are familiar with the basic characteristics of operator algebras, especially with their representation and ideal theory;
- construct groupoids and operator algebras from different geometrical objects and apply non-commutative geometry to these domains;
- know the spectral theory of commutative C*-algebras and analyse normal operators in Hilbert spaces with it;
- know important examples of simple C*-algebras and deduce their basic characteristics;
- apply basic concepts of category theory to C*-algebras;
- model the symmetries of non-commutative spaces;
- apply Hilbert modules in C*-algebras;
- know the definition of the K-theory of C*-algebras and their formal characteristics and calculate the K-theory of C*-algebras for important examples with it;
- apply operator algebras for the formulation and analysis of index problems in geometry and for the analysis of the geometry of greater length scales;
- compare different analytical and geometrical models for the construction of mappings between K-theory groups and apply them;
- classify and analyse quantisations of manifolds via Poisson structures and know a few important methods for the construction of quantisations;
- classify W*-algebras and know the intrinsic dynamic of factors;
- apply von Neumann algebras to the axiomatic formulation of quantum field theory;
- use von Neumann algebras for the construction of L2 invariants for manifolds and groups;
- understand the connection between the analysis of C*- and W*-algebras of groups and geometrical characteristics of groups;
- define the invariants of algebras and modules with chain complexes and their homology and calculate these;

Workload:

Attendance time:
84 h

Self-study time:
186 h

• interpret these homological invariants geometrically and correlate them with each other; • abstract new concepts from the fundamental characteristics of K-theory and other homology theories, e. g. triangulated categories. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Non-commutative geometry"; • explain basic ideas of proof in the area "Non-commutative geometry"; • illustrate typical applications in the area "Non-commutative geometry".	

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3125.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Non-commutative geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1100, B.Mat.1200
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.3131: Introduction to inverse problems**	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Inverse problems" enables students to learn methods, concepts, theories and applications in the area of "Inverse problems". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the phenomenon of illposedness and identify the degree of illposedness of typical inverse problems; • evaluate different regularisation methods for ill posed inverse problems under algorithmic aspects and with regard to various a priori information and distinguish concepts of convergence for such methods with deterministic and stochastic data errors; • analyse the convergence of regularisation methods with the help of spectral theory of bounded self-adjoint operators; • analyse the convergence of regularisation methods with the help of complex analysis; • analyse regularisation methods from stochastic error models; • apply fully data-driven models for the choice of regularisation parameters and evaluate these for concrete problems; • model identification problems in natural sciences and technology as inverse problems of partial differential equations where the unknown is e. g. a coefficient, an initial or a boundary condition or the shape of a region; • analyse the uniqueness and conditional stability of inverse problems of partial differential equations; • deduce sampling and testing methods for the solution of inverse problems of partial differential equations and analyse the convergence of such methods; • formulate mathematical models of medical imaging like computed tomography (CT) or magnetic resonance tomography (MRT) and know the basic characteristics of corresponding operators. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Inverse problems"; • explain basic ideas of proof in the area "Inverse problems"; • illustrate typical applications in the area "Inverse problems".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: written examination (120 minutes) or oral examination (appr. 20 minutes)	9 C

Examination prerequisites: B.Mat.3131.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Inverse problems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3132: Introduction to approximation methods	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Approximation methods" enables students to learn methods, concepts, theories and applications in the area of "Approximation methods", so the approximation of one- and multidimensional functions as well as for the analysis and approximation of discrete signals and images. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of approximation problems in suitable finite- and infinite-dimensional vector spaces; • can confidently handle models for the approximation of one- and multidimensional functions in Banach and Hilbert spaces; • know and use parts of classical approximation theory, e. g. Jackson and Bernstein theorems for the approximation quality for trigonometrical polynomials, approximation in translationally invariant spaces; polynomial reductions and Strang-Fix conditions; • acquire knowledge of continuous and discrete approximation problems and their corresponding solution strategies both in the one- and multidimensional case; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods for the efficient solution of the approximation problems on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear approximation methods for multidimensional data; • are informed about current developments of efficient data approximation and data analysis; • adapt solution strategies for the data approximation using special structural characteristics of the approximation problem that should be solved. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Approximation methods"; • explain basic ideas of proof in the area "Approximation methods" for one- and multidimensional data; • illustrate typical applications in the area of data approximation and data analysis.	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH

Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3132.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Approximation methods"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module B.Mat.3133: Introduction to numerics of partial differential equations**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Numerics of partial differential equations" enables students to learn methods, concepts, theories and applications in the area of "Numerics of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of linear partial differential equations, e. g. questions of classification as well as existence, uniqueness and regularity of the solution; • know the basics of the theory of linear integral equations; • are familiar with basic methods for the numerical solution of linear partial differential equations with finite difference methods (FDM), finite element methods (FEM) as well as boundary element methods (BEM); • analyse stability, consistence and convergence of FDM, FEM and BEM for linear problems; • apply methods for adaptive lattice refinement on the basis of a posteriori error approximations; • know methods for the solution of larger systems of linear equations and their preconditioners and parallelisation; • apply methods for the solution of larger systems of linear and stiff ordinary differential equations and are familiar with the problem of differential algebraic problems; • apply available software for the solution of partial differential equations and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge in the theory as well as development and application of numerical solution strategies in a special area of partial differential equations, e. g. in variation problems with constraints, singularly perturbed problems or of integral equations; • know propositions about the theory of non-linear partial differential equations of monotone and maximally monotone type as well as suitable iterative solution methods. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Numerics of partial differential equations"; • explain basic ideas of proof in the area "Numerics of partial differential equations"; • illustrate typical applications in the area "Numerics of partial differential equations".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3133.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Numerics of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module B.Mat.3134: Introduction to optimisation**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Optimisation" enables students to learn methods, concepts, theories and applications in the area of "Optimisation", so the discrete and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • identify optimisation problems in application-oriented problems and formulate these as mathematical programmes; • evaluate the existence and uniqueness of the solution of an optimisation problem; • identify structural characteristics of an optimisation problem, amongst others the existence of a finite candidate set, the structure of the underlying level set; • know which special characteristics of the target function and the constraints (like (virtual) convexity, dc functions) for the development of solution strategies can be utilised; • analyse the complexity of an optimisation problem; • classify a mathematical programme in a class of optimisation problems and know current solution strategies for it; • develop optimisation methods and adapt general methods to special problems; • deduce upper and lower bounds for optimisation problems and understand their meaning; • understand the geometrical structure of an optimisation problem and apply it for solution strategies; • distinguish between proper solution methods, approximation methods with quality guarantee and heuristics and evaluate different methods on the basis of the quality of the found solutions and their computing times; • acquire advanced knowledge in the development of solution strategies on the basis of a special area of optimisation, e. g. integer optimisation, optimisation of networks or convex optimisation; • acquire advanced knowledge for the solution of special optimisation problems of an application-oriented area, e. g. traffic planning or location planning; • handle advanced optimisation problems, like e. g. optimisation problems with uncertainty or multi-criteria optimisation problems. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Optimisation"; • explain basic ideas of proof in the area "Optimisation"; • illustrate typical applications in the area "Optimisation".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3134.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Optimisation"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3137: Introduction to variational analysis	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Variational analysis" enables students to learn methods, concepts, theories and applications in variational analysis and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- understand basic concepts of convex and variational analysis for finite- and infinite-dimensional problems;
- master the characteristics of convexity and other concepts of the regularity of sets and functions to evaluate the existence and regularity of the solutions of variational problems;
- understand basic concepts of the convergence of sets and continuity of set-valued functions;
- understand basic concepts of variational geometry;
- calculate and use generalised derivations (subderivatives and subgradients) of non-smooth functions;
- understand the different concepts of regularity of set-valued functions and their effects on the calculation rules for subderivatives of non-convex functionals;
- analyse constrained and parametric optimisation problems with the help of duality theory;
- calculate and use the Legendre-Fenchel transformation and infimal convulutions;
- formulate optimality criteria for continuous optimisation problems with tools of convex and variational analysis;
- apply tools of convex and variational analysis to solve generalised inclusions that e. g. originate from first-order optimality criteria;
- understand the connection between convex functions and monotone operators;
- examine the convergence of fixed point iterations with the help of the theory of monotone operators;
- deduce methods for the solution of smooth and non-smooth continuous constrained optimisation problems and analyse their convergence;
- apply numerical methods for the solution of smooth and non-smooth continuous constrained programs to current problems;
- model application problems with variational inequations, analyse their characteristics and are familiar with numerical methods for the solution of variational inequations;
- know applications of control theory and apply methods of dynamic programming;
- use tools of variational analysis in image processing and with inverse problems;
- know basic concepts and methods of stochastic optimisation.

Core skills:

Workload:

Attendance time:
84 h

Self-study time:
186 h

After having successfully completed the module, students will be able to • discuss basic concepts of the area "Variational analysis"; • explain basic ideas of proof in the area "Variational analysis"; • illustrate typical applications in the area "Variational analysis".	

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) (120 minutes) **Examination prerequisites:** B.Mat.3137.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Variational analysis"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3138: Introduction to image and geometry processing	9 C 6 WLH

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Learning outcome, core skills:
Learning outcome:

The successful completion of modules of the cycle "Image and geometry processing" enables students to learn and apply methods, concepts, theories and applications in the area of "Image and geometry processing", so the digital image and geometry processing. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with the modelling of problems of image and geometry processing in suitable finite- and infinite-dimensional vector spaces;
- learn basic methods for the analysis of one- and multidimensional functions in Banach and Hilbert spaces;
- learn basic mathematical concepts and methods that are used in image processing, like Fourier and Wavelet transform;
- learn basic mathematical concepts and methods that play a central role in geometry processing, like curvature of curves and surfaces;
- acquire knowledge about continuous and discrete problems of image data analysis and their corresponding solution strategies;
- know basic concepts and methods of topology;
- are familiar with visualisation software;
- apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically;
- know which special characteristics of an image or of a geometry can be extracted and worked on with which methods;
- evaluate different numerical methods for the efficient analysis of multidimensional data on the basis of the quality of the solutions, the complexity and their computing time;
- acquire advanced knowledge about linear and non-linear methods for the geometrical and topological analysis of multidimensional data;
- are informed about current developments of efficient geometrical and topological data analysis;
- adapt solution strategies for the data analysis using special structural characteristics of the given multidimensional data.

Core skills:

After having successfully completed the module, students will be able to

- discuss basic concepts of the area "Image and geometry processing";
- explain basic ideas of proof in the area "Image and geometry processing";
- illustrate typical applications in the area "Image and geometry processing".

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Workload:
Attendance time:
84 h
Self-study time:
186 h

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Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3138.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Image and geometry processing"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3139: Introduction to scientific computing / applied mathematics	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Scientific computing / applied mathematics" enables students to learn and apply methods, concepts, theories and applications in the area of "Scientific computing / Applied mathematics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of basic mathematical models of the corresponding subject area, especially about the existence and uniqueness of solutions; • know basic methods for the numerical solution of these models; • analyse stability, convergence and efficiency of numerical solution strategies; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • are informed about current developments of scientific computing, like e. g. GPU computing and use available soft- and hardware; • use methods of scientific computing for solving application problems, like e. g. of natural and business sciences. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Scientific computing / applied mathematics"; • explain basic ideas of proof in the area "Scientific computing / applied mathematics"; • illustrate typical applications in the area "Scientific computing / applied mathematics".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: written examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3139.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements:	

Proof of knowledge and mastery of basic competencies in the area "Scientific computing / applied mathematics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1300
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

<table>
<tr><td>Georg-August-Universität Göttingen
Module B.Mat.3141: Introduction to applied and mathematical stochastics</td><td>9 C
6 WLH</td></tr>
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Learning outcome, core skills:
Learning outcome:
The successful completion of modules of the cycle "Applied and mathematical stochastics" enables students to understand and apply a broad range of problems, theories, modelling and proof techniques of stochastics. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued: Students

are familiar with advanced concepts of probability theory established on measure theory and apply them independently;
are familiar with substantial concepts and approaches of probability modelling and inferential statistics;
know basic characteristics of stochastic processes as well as conditions for their existence and uniqueness;
have a pool of different stochastic processes in time and space at their disposal and characterise those, differentiate them and quote examples;
understand and identify basic characteristics of invariance of stochastic processes like stationary processes and isotropy;
analyse the convergence characteristic of stochastic processes;
analyse regularity characteristics of the paths of stochastic processes;
adequately model temporal and spatial phenomena in natural and economic sciences as stochastic processes, if necessary with unknown parameters;
analyse probabilistic and statistic models regarding their typical characteristics, estimate unknown parameters and make predictions for their paths on areas not observed / at times not observed;
discuss and compare different modelling approaches and evaluate the reliability of parameter estimates and predictions sceptically.

Core skills:
After having successfully completed the module, students will be able to

discuss basic concepts of the area "Applied and mathematical stochastics";
explain basic ideas of proof in the area "Applied and mathematical stochastics";
illustrate typical applications in the area "Applied and mathematical stochastics".

</td><td>Workload:
Attendance time:
84 h
Self-study time:
186 h</td></tr>
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<tr><td>Course: Lecture course (Lecture)</td><td>4 WLH</td></tr>
<tr><td>Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes)
Examination prerequisites:</td><td>9 C</td></tr>
</table>

B.Mat.3141.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Applied and mathematical stochastics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module B.Mat.3142: Introduction to stochastic processes	9 C 6 WLH

Learning outcome, core skills:	Workload:

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Stochastic processes" enables students to learn and apply methods, concepts, theories and proof techniques in the area of "Stochastic processes" and use these for the modelling of stochastic systems. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with advanced concepts of probability theory established on measure theory and apply them independently;
- know basic characteristics as well as existence and uniqueness results for stochastic processes and formulate suitable probability spaces;
- understand the relevance of the concepts of filtration, conditional expectation and stopping time for the theory of stochastic processes;
- know fundamental classes of stochastic processes (like e. g. Poisson processes, Brownian motions, Levy processes, stationary processes, multivariate and spatial processes as well as branching processes) and construct and characterise these processes;
- analyse regularity characteristics of the paths of stochastic processes;
- construct Markov chains with discrete and general state spaces in discrete and continuous time, classify their states and analyse their characteristics;
- are familiar with the theory of general Markov processes and characterise and analyse these with the use of generators, semigroups, martingale problems and Dirichlet forms;
- analyse martingales in discrete and continuous time using the corresponding martingale theory, especially using martingale equations, martingale convergence theorems, martingale stopping theorems and martingale representation theorems;
- formulate stochastic integrals as well as stochastic differential equations with the use of the Ito calculus and analyse their characteristics;
- are familiar with stochastic concepts in general state spaces as well as with the topologies, metrics and convergence theorems relevant for stochastic processes;
- know fundamental convergence theorems for stochastic processes and generalise these;
- model stochastic systems from different application areas in natural sciences and technology with the aid of suitable stochastic processes;
- analyse models in mathematical economics and finance and understand evaluation methods for financial products.

Core skills:

After having successfully completed the module, students will be able to

- discuss basic concepts of the area "Stochastic processes";

Workload:

Attendance time:
84 h
Self-study time:
186 h

• explain basic ideas of proof in the area "Stochastic processes"; • illustrate typical applications in the area "Stochastic processes".	

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3142.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Stochastic processes"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3143: Introduction to stochastic methods of economathematics**	9 C 6 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Stochastic methods of economathematics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master problems, basic concepts and stochastic methods of economathematics; • understand stochastic connections; • understand references to other mathematical areas; • get to know possible applications in theory and practice; • gain insight into the connection of mathematics and economic sciences. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Stochastic methods of economathematics"; • explain basic ideas of proof in the area "Stochastic methods of economathematics"; • illustrate typical applications in the area "Stochastic methods of economathematics".	**Workload:** Attendance time: 84 h Self-study time: 186 h
Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3143.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C
Course: Exercise session (Exercise)	2 WLH
Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Stochastic methods of economathematics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency:	**Duration:**

not specified	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3144: Introduction to mathematical statistics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Mathematical statistics" enables students to learn methods, concepts, theories and applications in the area of "Mathematical statistics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of mathematical statistics like estimates, testing, confidence propositions and classification and use them in simple models of mathematical statistics; • evaluate statistical methods mathematically precisely via suitable risk and loss concepts; • analyse optimality characteristics of statistical estimate methods via lower and upper bounds; • analyse the error rates of statistical testing and classification methods based on the Neyman Pearson theory; • are familiar with basic statistical distribution models that base on the theory of exponential indexed families; • know different techniques to obtain lower and upper risk bounds in these models; • are confident in modelling typical data structures of regression; • analyse practical statistical problems in a mathematically accurate way with the techniques learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of mathematical statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Mathematical statistics"; • explain basic ideas of proof in the area "Mathematical statistics"; • illustrate typical applications in the area "Mathematical statistics".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes)	9 C

Examination prerequisites: B.Mat.3144.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Mathematical statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3145: Introduction to statistical modelling and inference**	9 C 6 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Statistical modelling and inference" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the fundamental principles of statistics and inference in parametric and non-parametric models: estimation, testing, confidence statements, prediction, model selection and validation; • are familiar with the tools of asymptotic statistical inference; • learn Bayes and frequentist approaches to data modelling and inference, as well as the interplay between both, in particular empirical Bayes methods; • are able to implement Monte Carlo statistical methods for Bayes and frequentist inference and learn their theoretical properties; • become confident in non-parametric (regression) modelling and inference for various types of the data: count, categorical, dependent, etc.; • are able to develop and mathematically evaluate complex statistical models for real data problems. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Statistical modelling and inference"; • explain basic ideas of proof in the area "Statistical modelling and inference"; • illustrate typical applications in the area "Statistical modelling and inference".	**Workload:** Attendance time: 84 h Self-study time: 186 h
Course: Lecture course (Lecture)	4 WLH
Examination: Written or oral examoral examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3145.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C
Course: Exercise session (Exercise)	2 WLH
Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Statistical modelling and inference"	

Admission requirements:	**Recommended previous knowledge:**

none	B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3146: Introduction to multivariate statistics**	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Multivariate statistics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are well acquainted with the most important methods of multivariate statistics like estimation, testing, confidence statements, prediction, linear and generalized linear models, and use them in modeling real world applications; • can apply more specific methods of multivariate statistics such as dimension reduction by principal component analysis (PCA), factor analysis and multidimensional scaling; • are familiar with handling non-Euclidean data such as directional or shape data using parametric and non-parametric models; • are confident using nested descriptors for non-Euclidean data and Procrustes methods in shape analysis; • are familiar with time dependent data, basic functional data analysis and inferential concepts such as kinematic formulae; • analyze basic dependencies between topology/geometry of underlying spaces and asymptotic limiting distributions; • are confident to apply resampling methods to non-Euclidean descriptors; • are familiar with high-dimensional discrimination and classification techniques such as kernel PCA, regularization methods and support vector machines; • have a fundamental knowledge of statistics of point processes and Bayesian methods involved; • are familiar with concepts of large scale computational statistical techniques; • independently become acquainted with a current topic of multivariate and non-Euclidean statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Multivariate statistics"; • explain basic ideas of proof in the area "Multivariate statistics"; • illustrate typical applications in the area "Multivariate statistics".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH

Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3146.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Multivariate statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3147: Introduction to statistical foundations of data science**	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Statistical foundations of data science" enables students to learn methods, concepts, theories and applications in the area of "Statistical foundations of data science". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of statistical foundations of data science like estimation, testing, confidence statements, prediction, resampling, pattern recognition and classification, and use them in modeling real world applications; • evaluate statistical methods mathematically precisely via suitable statistical risk and loss concepts; • analyse characteristics of statistical estimation methods via lower and upper information bounds; • are familiar with basic statistical distribution models that base on the theory of exponential families; • are confident in modelling real world data structures such as categorial data, multidimensional and high dimensional data, data in imaging, data with serial dependencies • analyse practical statistical problems in a mathematically accurate way with the techniques and models learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with concepts of large scale computational statistical techniques; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of statistical data science; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Statistical foundations of data science"; • explain basic ideas of proof in the area "Statistical foundations of data science"; • illustrate typical applications in the area "Statistical foundations of data science".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: written examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:** B.Mat.3147.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of knowledge and mastery of basic competencies in the area "Statistical foundations of data science"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3311: Advances in analytic number theory**	9 C 6 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Analytic number theory" enables students to learn methods, concepts, theories and applications in the area of "Analytic number theory". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • solve arithmetical problems with basic, complex-analytical, and Fourier-analytical methods; • know characteristics of the Riemann zeta function and more general L-functions, and apply them to problems of number theory; • are familiar with results and methods of prime number theory; • acquire knowledge in arithmetical and analytical theory of automorphic forms, and its application in number theory; • know basic sieving methods and apply them to the problems of number theory; • know techniques used to estimate the sum of the sum of characters and of exponentials; • analyse the distribution of rational points on suitable algebraic varieties using analytical techniques; • master computation with asymptotic formulas, asymptotic analysis, and asymptotic equipartition in number theory. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Analytic number theory" confidently; • explain complex issues of the area "Analytic number theory"; • apply methods of the area "Analytic number theory" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h
Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3311.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C
Course: Exercise session (Exercise)	2 WLH
Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Analytic number theory"	

Admission requirements:	**Recommended previous knowledge:**

none	B.Mat.3111
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3111 "Introduction to analytic number theory"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.3312: Advances in analysis of partial differential equations**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Analysis of partial differential equations" enables students to learn methods, concepts, theories and applications in the area "Analysis of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important types of partial differential equations and know their solutions; • master the Fourier transform and other techniques of the harmonic analysis to analyse partial differential equations; • are familiar with the theory of generalised functions and the theory of function spaces and use these for solving differential partial equations; • apply the basic principles of functional analysis to the solution of partial different equations; • use different theorems of function theory for solving partial different equations; • master different asymptotic techniques to study characteristics of the solutions of partial different equations; • are paradigmatically familiar with broader application areas of linear theory of partial different equations; • are paradigmatically familiar with broader application areas of non-linear theory of partial different equations; • know the importance of partial different equations in the modelling in natural and engineering sciences; • master some advanced application areas like parts of microlocal analysis or parts of algebraic analysis. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Analysis of partial differential equations" confidently; • explain complex issues of the area "Analysis of partial differential equations"; • apply methods of the area "Analysis of partial differential equations" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3312.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Analysis of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3112
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3112 "Introduction to analysis of partial differential equations"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.3313: Advances in differential geometry**	9 C 6 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Differential geometry" enables students to learn methods, concepts, theories and applications in the area "Differential geometry". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master the basic concepts of differential geometry; • develop a spatial sense using the examples of curves, surfaces and hypersurfaces; • develop an understanding of the basic concepts of differential geometry like "space" and "manifolds", "symmetry" and "Lie group", "local structures" and "curvature", "global structure" and "invariants" as well as "integrability"; • master (variably weighted and sorted depending on the current courses offered) the theory of transformation groups and symmetries as well as the analysis on manifolds, the theory of manifolds with geometric structures, complex differential geometry, gauge field theory and their applications as well as the elliptical differential equations of geometry and gauge field theory; • develop an understanding for geometrical constructs, spatial patterns and the interaction of algebraic, geometrical, analytical and topological methods; • acquire the skill to apply methods of analysis, algebra and topology for the treatment of geometrical problems; • are able to import geometrical problems to a broader mathematical and physical context. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Differential geometry" confidently; • explain complex issues of the area "Differential geometry"; • apply methods of the area "Differential geometry" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3313.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements:	

Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Differential geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3113
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3113 "Introduction to differential geometry"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module B.Mat.3314: Advances in algebraic topology	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic topology" students get to know the most important classes of topological spaces as well as algebraic and analytical tools for studying these spaces and the mappings between them. The students use these tools in geometry, mathematical physics, algebra and group theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic topology uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic topology and supplement one another complementarily. The following content-related competencies are pursued. Students • know the basic concepts of set-theoretic topology and continuous mappings; • construct new topologies from given topologies; • know special classes of topological spaces and their special characteristics like CW complexes, simplicial complexes and manifolds; • apply basic concepts of category theory to topological spaces; • use concepts of functors to obtain algebraic invariants of topological spaces and mappings; • know the fundamental group and the covering theory as well as the basic methods for the computation of fundamental groups and mappings between them; • know homology and cohomology, calculate those for important examples and with the aid of these deduce non-existence of mappings as well as fixed-point theorems; • calculate homology and cohomology with the aid of chain complexes; • deduce algebraic characteristics of homology and cohomology with the aid of homological algebra; • become acquainted with connections between analysis and topology; • apply algebraic structures to deduce special global characteristics of the cohomology of a local structure of manifolds. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Algebraic topology" confidently; • explain complex issues of the area "Algebraic topology"; • apply methods of the area "Algebraic topology" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes)	9 C

Examination prerequisites: B.Mat.3314.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Algebraic topology"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3114
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3114 "Introduction to algebraic topology"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module B.Mat.3315: Advances in mathematical methods in physics	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Mathematical methods of physics" students get to know different mathematical methods and techniques that play a role in modern physics. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. The topics of the cycle can be divided into four blocks, a cycle normally contains parts of different blocks, that topically supplement each other, but can also be read within one block. The introducing parts of the cycle form the basis for the advanced specialisation area. The topic blocks are • harmonic analysis, algebraic structures and representation theory, (group) effects; • operator algebra, C* algebra and von-Neumann algebra; • operator theory, perturbation and scattering theory, special PDE, microlocal analysis, distributions; • (semi) Riemannian geometry, symplectic and Poisson geometry, quantization. One of the aims is that a connection to physical problems is visible, at least in the motivation of the covered topics. Preferably, in the advanced part of the cycle, the students should know and be able to carry out practical applications themselves. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Mathematical methods in physics" confidently; • explain complex issues of the area "Mathematical methods in physics"; • apply methods of the area "Mathematical methods in physics" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3315.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Mathematical methods in physics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3115

Language: English	**Person responsible for module:** Dean of studies
Course frequency: on an irregular basis	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.3321: Advances in algebraic geometry**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic geometry" students get to know the most important classes of algebraic varieties and schemes as well as the tools for studying these objects and the mappings between them. The students apply these skills to problems of arithmetic or complex analysis. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic geometry uses and connects concepts of algebra and geometry and can be used versatilely. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic geometry and supplement one another complementarily. The following content-related competencies are pursued. Students • are familiar with commutative algebra, also in greater detail; • know the concepts of algebraic geometry, especially varieties, schemes, sheafs, bundles; • examine important examples like elliptic curves, Abelian varieties or algebraic groups; • use divisors for classification questions; • study algebraic curves; • prove the Riemann-Roch theorem and apply it; • use cohomological concepts and know the basics of Hodge theory; • apply methods of algebraic geometry to arithmetical questions and obtain e. g. finiteness principles for rational points; • classify singularities and know the significant aspects of the dimension theory of commutative algebra and algebraic geometry; • get to know connections to complex analysis and to complex geometry. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Algebraic geometry" confidently; • explain complex issues of the area "Algebraic geometry"; • apply methods of the area "Algebraic geometry" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3321.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Algebraic geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3121
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3121 "Introduction to algebraic geometry"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.3322: Advances in algebraic number theory**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Algebraic number theory" enables students to learn methods, concepts, theories and applications in the areas "Algebraic number theory" and "Algorithmic number theory". During the course of the cycle students will be successively introduced to current theoretical and/or applied research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued in relation to algebra. Students • know Noetherian and Dedekind rings and the class groups; • are familiar with discriminants, differents and bifurcation theory of Hilbert; • know geometrical number theory with applications to the unit theorem and the finiteness of class groups as well as the algorithmic aspects of lattice theory (LLL); • are familiar with L-series and zeta functions and discuss the algebraic meaning of their residues; • know densities, the Tchebotarew theorem and applications; • work with orders, S-integers and S-units; • know the class field theory of Hilbert, Takagi and Idele theoretical field theory; • are familiar with Zp-extensions and their Iwasawa theory; • discuss the most important hypotheses of Iwasawa theory and their consequences. Concerning algorithmic aspects of number theory, the following competencies are pursued. Students • work with algorithms for the identification of short lattice bases, nearest points in lattices and the shortest vectors; • are familiar with basic algorithms of number theory in long arithmetic like GCD, fast number and polynomial arithmetic, interpolation and evaluation and prime number tests; • use the sieving method for factorisation and calculation of discrete logarithms in finite fields of great characteristics; • discuss algorithms for the calculation of the zeta function of elliptic curves and Abelian varieties of finite fields; • calculate class groups and fundamental units; • calculate Galois groups of absolute number fields. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Algebraic number theory" confidently; • explain complex issues of the area "Algebraic number theory"; • apply methods of the area "Algebraic number theory" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3322.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessionsungen	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Algebraic number theory"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3122
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3122 "Introduction to algebraic number theory"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module B.Mat.3323: Advances in algebraic structures	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic structures" students get to know different algebraic structures, amongst others Lie algebras, Lie groups, analytical groups, associative algebras as well as the tools from algebra, geometry and category theory that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic structures use concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic structures and supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts like rings, modules, algebras and Lie algebras; • know important examples of Lie algebras and algebras; • know special classes of Lie groups and their special characteristics; • know classification theorems for finite-dimensional algebras; • apply basic concepts of category theory to algebras and modules; • know group actions and their basic classifications; • apply the enveloping algebra of Lie algebras; • apply ring and module theory to basic constructs of algebraic geometry; • use combinatorial tools for the study of associative algebras and Lie algebras; • acquire solid knowledge of the representation theory of Lie algebras, finite groups and compact Lie groups as well as the representation theory of semisimple Lie groups; • know Hopf algebras as well as their deformation and representation theory. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Algebraic structures" confidently; • explain complex issues of the area "Algebraic structures"; • apply methods of the area "Algebraic structures" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3323.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Algebraic structures"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3123
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3123 "Introduction to algebraic structures"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

<table>
<tr><td>Georg-August-Universität Göttingen
Module B.Mat.3324: Advances in groups, geometry and dynamical systems</td><td>9 C
6 WLH</td></tr>
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Learning outcome, core skills:

Learning outcome:

In the modules of the cycle "Groups, geometry and dynamical systems" students get to know the most important classes of groups as well as the algebraic, geometrical and analytical tools that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis.

Group theory uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of the area "Groups, geometry and dynamical systems" that supplement one another complementarily. The following content-related competencies are pursued. Students

- know basic concepts of groups and group homomorphisms;
- know important examples of groups;
- know special classes of groups and their special characteristics;
- apply basic concepts of category theory to groups and define spaces via universal properties;
- apply the concepts of functors to obtain algebraic invariants;
- know group actions and their basic classification results;
- know the basics of group cohomology and compute these for important examples;
- know the basics of geometrical group theory like growth characteristics;
- know self-similar groups, their basic constructs as well as examples with interesting characteristics;
- use geometrical and combinatorial tools for the study of groups;
- know the basics of the representation theory of compact Lie groups.

Core skills:

After having successfully completed the module, students will be able to

- handle methods and concepts of the area "Groups, geometry and dynamical systems" confidently;
- explain complex issues of the area "Groups, geometry and dynamical systems";
- apply methods of the area "Groups, geometry and dynamical systems" to new problems in this area.

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Workload:

Attendance time:

84 h

Self-study time:

186 h

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Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3324.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Groups, geometry and dynamical systems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3124
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3124 "Introduction to groups, geometry and dynamical systems"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module B.Mat.3325: Advances in non-commutative geometry	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Non-commutative geometry" students get to know the conception of space of non-commutative geometry and some of its applications in geometry, topology, mathematical physics, the theory of dynamical systems and number theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Non-commutative geometry uses concepts of analysis, algebra, geometry and mathematical physics and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of non-commutative geometry that supplement one another complementarily. The following content-related competencies are pursued. Students • are familiar with the basic characteristics of operator algebras, especially with their representation and ideal theory; • construct groupoids and operator algebras from different geometrical objects and apply non-commutative geometry to these domains; • know the spectral theory of commutative C*-algebras and analyse normal operators in Hilbert spaces with it; • know important examples of simple C*-algebras and deduce their basic characteristics; • apply basic concepts of category theory to C*-algebras; • model the symmetries of non-commutative spaces; • apply Hilbert modules in C*-algebras; • know the definition of the K-theory of C*-algebras and their formal characteristics and calculate the K-theory of C*-algebras for important examples with it; • apply operator algebras for the formulation and analysis of index problems in geometry and for the analysis of the geometry of greater length scales; • compare different analytical and geometrical models for the construction of mappings between K-theory groups and apply them; • classify and analyse quantisations of manifolds via Poisson structures and know a few important methods for the construction of quantisations; • classify W*-algebras and know the intrinsic dynamic of factors; • apply von Neumann algebras to the axiomatic formulation of quantum field theory; • use von Neumann algebras for the construction of L2 invariants for manifolds and groups; • understand the connection between the analysis of C*- and W*-algebras of groups and geometrical characteristics of groups; • define the invariants of algebras and modules with chain complexes and their homology and calculate these;	**Workload:** Attendance time: 84 h Self-study time: 186 h

• interpret these homological invariants geometrically and correlate them with each other; • abstract new concepts from the fundamental characteristics of K-theory and other homology theories, e. g. triangulated categories. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Non-commutative geometry" confidently; • explain complex issues of the area "Non-commutative geometry"; • apply methods of the area "Non-commutative geometry" to new problems in this area.	

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3325.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Non-commutative geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3125
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3125 "Introduction to non-commutative geometry"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module B.Mat.3331: Advances in inverse problems**	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Inverse problems" enables students to learn methods, concepts, theories and applications in the area of "Inverse problems". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the phenomenon of illposedness and identify the degree of illposedness of typical inverse problems; • evaluate different regularisation methods for ill posed inverse problems under algorithmic aspects and with regard to various a priori information and distinguish concepts of convergence for such methods with deterministic and stochastic data errors; • analyse the convergence of regularisation methods with the help of spectral theory of bounded self-adjoint operators; • analyse the convergence of regularisation methods with the help of complex analysis; • analyse regularisation methods from stochastic error models; • apply fully data-driven models for the choice of regularisation parameters and evaluate these for concrete problems; • model identification problems in natural sciences and technology as inverse problems of partial differential equations where the unknown is e. g. a coefficient, an initial or a boundary condition or the shape of a region; • analyse the uniqueness and conditional stability of inverse problems of partial differential equations; • deduce sampling and testing methods for the solution of inverse problems of partial differential equations and analyse the convergence of such methods; • formulate mathematical models of medical imaging like computer tomography (CT) or magnetic resonance tomography (MRT) and know the basic characteristics of corresponding operators. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Inverse problems" confidently; • explain complex issues of the area "Inverse problems"; • apply methods of the area "Inverse problems" to new problems in this area.	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3331.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Inverse problems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3131
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3131 "Introduction to inverse problems"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3332: Advances in approximation methods	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Approximation methods" enables students to learn methods, concepts, theories and applications in the area of "Approximation methods", so the approximation of one- and multidimensional functions as well as for the analysis and approximation of discrete signals and images. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with the modelling of approximation problems in suitable finite- and infinite-dimensional vector spaces;
- can confidently handle models for the approximation of one- and multidimensional functions in Banach and Hilbert spaces;
- know and use parts of classical approximation theory, e. g. Jackson and Bernstein theorems for the approximation quality for trigonometrical polynomials, approximation in translationally invariant spaces; polynomial reductions and Strang-Fix conditions;
- acquire knowledge of continuous and discrete approximation problems and their corresponding solution strategies both in the one- and multidimensional case;
- apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically;
- evaluate different numerical methods for the efficient solution of the approximation problems on the basis of the quality of the solutions, the complexity and their computing time;
- acquire advanced knowledge about linear and non-linear approximation methods for multidimensional data;
- are informed about current developments of efficient data approximation and data analysis;
- adapt solution strategies for the data approximation using special structural characteristics of the approximation problem that should be solved.

Core skills:

After having successfully completed the module, students will be able to

- handle methods and concepts of the area "Approximation methods" confidently;
- explain complex issues of the area "Approximation methods";
- apply methods of the area "Approximation methods" to new problems in this area.

Workload:

Attendance time:
84 h

Self-study time:
186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3332.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Approximation methods"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3132
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3132 "Introduction to approximation methods"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module B.Mat.3333: Advances in numerics of partial differential equations**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Numerics of partial differential equations" enables students to learn methods, concepts, theories and applications in the area of "Numerics of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of linear partial differential equations, e. g. questions of classification as well as existence, uniqueness and regularity of the solution; • know the basics of the theory of linear integral equations; • are familiar with basic methods for the numerical solution of linear partial differential equations with finite difference methods (FDM), finite element methods (FEM) as well as boundary element methods (BEM); • analyse stability, consistence and convergence of FDM, FEM and BEM for linear problems; • apply methods for adaptive lattice refinement on the basis of a posteriori error approximations; • know methods for the solution of larger systems of linear equations and their preconditioners and parallelisation; • apply methods for the solution of larger systems of linear and stiff ordinary differential equations and are familiar with the problem of differential algebraic problems; • apply available software for the solution of partial differential equations and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge in the theory as well as development and application of numerical solution strategies in a special area of partial differential equations, e. g. in variation problems with constraints, singularly perturbed problems or of integral equations; • know propositions about the theory of non-linear partial differential equations of monotone and maximally monotone type as well as suitable iterative solution methods. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Numerics of partial differential equations" confidently; • explain complex issues of the area "Numerics of partial differential equations";	**Workload:** Attendance time: 84 h Self-study time: 186 h

• apply methods of the area "Numerics of partial differential equations" to new problems in this area.	

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3333.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Numerics of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3133
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3133 "Introduction to numerics of partial differential equations"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3334: Advances in optimisation	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Optimisation" enables students to learn methods, concepts, theories and applications in the area of "Optimisation", so the discrete and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- identify optimisation problems in application-oriented problems and formulate these as mathematical programmes;
- evaluate the existence and uniqueness of the solution of an optimisation problem;
- identify structural characteristics of an optimisation problem, amongst others the existence of a finite candidate set, the structure of the underlying level set;
- know which special characteristics of the target function and the constraints (like (virtual) convexity, dc functions) for the development of solution strategies can be utilised;
- analyse the complexity of an optimisation problem;
- classify a mathematical programme in a class of optimisation problems and know current solution strategies for it;
- develop optimisation methods and adapt general methods to special problems;
- deduce upper and lower bounds for optimisation problems and understand their meaning;
- understand the geometrical structure of an optimisation problem and apply it for solution strategies;
- distinguish between proper solution methods, approximation methods with quality guarantee and heuristics and evaluate different methods on the basis of the quality of the found solutions and their computing times;
- acquire advanced knowledge in the development of solution strategies on the basis of a special area of optimisation, e. g. integer optimisation, optimisation of networks or convex optimisation;
- acquire advanced knowledge for the solution of special optimisation problems of an application-oriented area, e. g. traffic planning or location planning;
- handle advanced optimisation problems, like e. g. optimisation problems with uncertainty or multi-criteria optimisation problems.

Core skills:

After having successfully completed the module, students will be able to

- handle methods and concepts of the area "Optimisation" confidently;
- explain complex issues of the area "Optimisation";
- apply methods of the area "Optimisation" to new problems in this area.

Workload:

Attendance time:
84 h

Self-study time:
186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3334.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Optimisation"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3134
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3134 "Introduction to optimisation"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: Instructor: Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module B.Mat.3337: Advances in variational analysis**	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Variational analysis" enables students to learn methods, concepts, theories and applications in the area of "Variational analysis" and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- understand basic concepts of convex and variational analysis for finite- and infinite-dimensional problems;
- master the characteristics of convexity and other concepts of the regularity of sets and functions to evaluate the existence and regularity of the solutions of variational problems;
- understand basic concepts of the convergence of sets and continuity of set-valued functions;
- understand basic concepts of variational geometry;
- calculate and use generalised derivations (subderivatives and subgradients) of non-smooth functions;
- understand the different concepts of regularity of set-valued functions and their effects on the calculation rules for subderivatives of non-convex functionals;
- analyse constrained and parametric optimisation problems with the help of duality theory;
- calculate and use the Legendre-Fenchel transformation and infimal convulutions;
- formulate optimality criteria for continuous optimisation problems with tools of convex and variational analysis;
- apply tools of convex and variational analysis to solve generalised inclusions that e. g. originate from first-order optimality criteria;
- understand the connection between convex functions and monotone operators;
- examine the convergence of fixed point iterations with the help of the theory of monotone operators;
- deduce methods for the solution of smooth and non-smooth continuous constrained optimisation problems and analyse their convergence;
- apply numerical methods for the solution of smooth and non-smooth continuous constrained programs to current problems;
- model application problems with variational inequations, analyse their characteristics and are familiar with numerical methods for the solution of variational inequations;
- know applications of control theory and apply methods of dynamic programming;
- use tools of variational analysis in image processing and with inverse problems;
- know basic concepts and methods of stochastic optimisation.

Core skills:

Workload:
Attendance time:
84 h
Self-study time:
186 h

After having successfully completed the module, students will be able to • handle methods and concepts of the area "Variational analysis" confidently; • explain complex issues of the area "Variational analysis"; • apply methods of the area "Variational analysis" to new problems in this area.	

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3337.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Variational analysis"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3137
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3137 "Introduction in variational analysis"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module B.Mat.3338: Advances in image and geometry processing	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Image and geometry processing" enables students to learn and apply methods, concepts, theories and applications in the area of "Image and geometry processing", so the digital image and geometry processing. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of problems of image and geometry processing in suitable finite- and infinite-dimensional vector spaces; • learn basic methods for the analysis of one- and multidimensional functions in Banach and Hilbert spaces; • learn basic mathematical concepts and methods that are used in image processing, like Fourier and Wavelet transform; • learn basic mathematical concepts and methods that play a central role in geometry processing, like curvature of curves and surfaces; • acquire knowledge about continuous and discrete problems of image data analysis and their corresponding solution strategies; • know basic concepts and methods of topology; • are familiar with visualisation software; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • know which special characteristics of an image or of a geometry can be extracted and worked on with which methods; • evaluate different numerical methods for the efficient analysis of multidimensional data on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear methods for the geometrical and topological analysis of multidimensional data; • are informed about current developments of efficient geometrical and topological data analysis; • adapt solution strategies for the data analysis using special structural characteristics of the given multidimensional data. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Image and geometry processing" confidently; • explain complex issues of the area "Image and geometry processing";	**Workload:** Attendance time: 84 h Self-study time: 186 h

• apply methods of the area "Image and geometry processing" to new problems in this area.	

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3338.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Image and geometry processing"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3138
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3138 "Introduction to image and geometry processing"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module B.Mat.3339: Advances in scientific computing / applied mathematics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Scientific computing / Applied mathematics" enables students to learn and apply methods, concepts, theories and applications in the area of "Scientific computing / Applied mathematics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of basic mathematical models of the corresponding subject area, especially about the existence and uniqueness of solutions; • know basic methods for the numerical solution of these models; • analyse stability, convergence and efficiency of numerical solution strategies; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • are informed about current developments of scientific computing, like e. g. GPU computing and use available soft- and hardware; • use methods of scientific computing for solving application problems, like e. g. of natural and business sciences. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Scientific computing / applied mathematics" confidently; • explain complex issues of the area "Scientific computing / applied mathematics"; • apply methods of the area "Scientific computing / applied mathematics" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3339.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Scientific computing / applied mathematics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3139
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3139 "Introduction to scientific computing / applied mathematics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module B.Mat.3341: Advances in applied and mathematical stochastics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Applied and mathematical stochastics" enables students to understand and apply a broad range of problems, theories, modelling and proof techniques of stochastics. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued: Students • are familiar with advanced concepts of probability theory established on measure theory and apply them independently; • are familiar with substantial concepts and approaches of probability modelling and inferential statistics; • know basic characteristics of stochastic processes as well as conditions for their existence and uniqueness; • have a pool of different stochastic processes in time and space at their disposal and characterise those, differentiate them and quote examples; • understand and identify basic characteristics of invariance of stochastic processes like stationary processes and isotropy; • analyse the convergence characteristic of stochastic processes; • analyse regularity characteristics of the paths of stochastic processes; • adequately model temporal and spatial phenomena in natural and economic sciences as stochastic processes, if necessary with unknown parameters; • analyse probabilistic and statistic models regarding their typical characteristics, estimate unknown parameters and make predictions for their paths on areas not observed / at times not observed; • discuss and compare different modelling approaches and evaluate the reliability of parameter estimates and predictions sceptically. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Applied and mathematical stochastics" confidently; • explain complex issues of the area "Applied and mathematical stochastics"; • apply methods of the area "Applied and mathematical stochastics" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3341.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Applied and mathematical stochastics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3141
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3141 "Introduction to applied and mathematical stochastics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3342: Advances in stochastic processes**	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Stochastic processes" enables students to learn and apply methods, concepts, theories and proof techniques in the area of "Stochastic processes" and use these for the modelling of stochastic systems. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with advanced concepts of probability theory established on measure theory and apply them independently; • know basic characteristics as well as existence and uniqueness results for stochastic processes and formulate suitable probability spaces; • understand the relevance of the concepts of filtration, conditional expectation and stopping time for the theory of stochastic processes; • know fundamental classes of stochastic processes (like e. g. Poisson processes, Brownian motions, Levy processes, stationary processes, multivariate and spatial processes as well as branching processes) and construct and characterise these processes; • analyse regularity characteristics of the paths of stochastic processes; • construct Markov chains with discrete and general state spaces in discrete and continuous time, classify their states and analyse their characteristics; • are familiar with the theory of general Markov processes and characterise and analyse these with the use of generators, semigroups, martingale problems and Dirichlet forms; • analyse martingales in discrete and continuous time using the corresponding martingale theory, especially using martingale equations, martingale convergence theorems, martingale stopping theorems and martingale representation theorems; • formulate stochastic integrals as well as stochastic differential equations with the use of the Ito calculus and analyse their characteristics; • are familiar with stochastic concepts in general state spaces as well as with the topologies, metrics and convergence theorems relevant for stochastic processes; • know fundamental convergence theorems for stochastic processes and generalise these; • model stochastic systems from different application areas in natural sciences and technology with the aid of suitable stochastic processes; • analyse models in mathematical economics and finance and understand evaluation methods for financial products. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Stochastic processes" confidently;	Attendance time: 84 h Self-study time: 186 h

• explain complex issues of the area "Stochastic processes"; • apply methods of the area "Stochastic processes" to new problems in this area.	

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3342.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Stochastic processes"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3142
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3142 "Introduction to stochastic processes"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3343: Advances in stochastic methods of economathematics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Stochastic methods of economathematics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master problems, basic concepts and stochastic methods of economathematics; • understand stochastic connections; • understand references to other mathematical areas; • get to know possible applications in theory and practice; • gain insight into the connection of mathematics and economic sciences. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Stochastic methods of economathematics" confidently; • explain complex issues of the area "Stochastic methods of economathematics"; • apply methods of the area "Stochastic methods of economathematics" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3343.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Stochastic methods of economathematics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3143
Language: English	**Person responsible for module:** Dean of studies
Course frequency:	**Duration:** 1 semester[s]

Usually subsequent to the module B.Mat.3143 "Introduction to stochastic methods of economathematics"	
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations:
Instructor: Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3344: Advances in mathematical statistics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Mathematical statistics" enables students to learn methods, concepts, theories and applications in the area of "Mathematical statistics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of mathematical statistics like estimates, testing, confidence propositions and classification and use them in simple models of mathematical statistics; • evaluate statistical methods mathematically precisely via suitable risk and loss concepts; • analyse optimality characteristics of statistical estimate methods via lower and upper bounds; • analyse the error rates of statistical testing and classification methods based on the Neyman Pearson theory; • are familiar with basic statistical distribution models that base on the theory of exponential indexed families; • know different techniques to obtain lower and upper risk bounds in these models; • are confident in modelling typical data structures of regression; • analyse practical statistical problems in a mathematically accurate way with the techniques learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of mathematical statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Mathematical statistics" confidently; • explain complex issues of the area "Mathematical statistics"; • apply methods of the area "Mathematical statistics" to new problems in this area	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3344.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Mathematical statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3144
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3144 "Introduction to mathematical statistics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module B.Mat.3345: Advances in statistical modelling and inference	9 C 6 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Statistical modelling and inference" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the fundamental principles of statistics and inference in parametric and non-parametric models: estimation, testing, confidence statements, prediction, model selection and validation; • are familiar with the tools of asymptotic statistical inference; • learn Bayes and frequentist approaches to data modelling and inference, as well as the interplay between both, in particular empirical Bayes methods; • are able to implement Monte Carlo statistical methods for Bayes and frequentist inference and learn their theoretical properties; • become confident in non-parametric (regression) modelling and inference for various types of the data: count, categorical, dependent, etc.; • are able to develop and mathematically evaluate complex statistical models for real data problems. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Statistical modelling and inference" confidently; • explain complex issues of the area "Statistical modelling and inference"; • apply methods of the area "Statistical modelling and inference" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h
Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3345.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C
Course: Exercise session (Exercise)	2 WLH
Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Statistical modelling and inference"	

Admission requirements:	**Recommended previous knowledge:**

none	B.Mat.3145
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3111 "Introduction to statistical modelling and inference"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3346: Advances in multivariate statistics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Multivariate statistics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are well acquainted with the most important methods of multivariate statistics like estimation, testing, confidence statements, prediction, linear and generalized linear models, and use them in modeling real world applications; • can apply more specific methods of multivariate statistics such as dimension reduction by principal component analysis (PCA), factor analysis and multidimensional scaling; • are familiar with handling non-Euclidean data such as directional or shape data using parametric and non-parametric models; • are confident using nested descriptors for non-Euclidean data and Procrustes methods in shape analysis; • are familiar with time dependent data, basic functional data analysis and inferential concepts such as kinematic formulae; • analyze basic dependencies between topology/geometry of underlying spaces and asymptotic limiting distributions; • are confident to apply resampling methods to non-Euclidean descriptors; • are familiar with high-dimensional discrimination and classification techniques such as kernel PCA, regularization methods and support vector machines; • have a fundamental knowledge of statistics of point processes and Bayesian methods involved; • are familiar with concepts of large scale computational statistical techniques; • independently become acquainted with a current topic of multivariate and non-Euclidean statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • handle methods and concepts of the area "Multivariate statistics" confidently; • explain complex issues of the area "Multivariate statistics"; • apply methods of the area "Multivariate statistics" to new problems in this area.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes)	9 C

Examination prerequisites: B.Mat.3346.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Multivariate statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3146
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3146 "Introduction to multivariate statistics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module B.Mat.3347: Advances in statistical foundations of data science**	9 C 6 WLH

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Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle ""Statistical foundations of data science" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with the most important methods of statistical foundations of data science like estimation, testing, confidence statements, prediction, resampling, pattern recognition and classification, and use them in modeling real world applications;
- evaluate statistical methods mathematically precisely via suitable statistical risk and loss concepts;
- analyse characteristics of statistical estimation methods via lower and upper information bounds;
- are familiar with basic statistical distribution models that base on the theory of exponential families;
- are confident in modelling real world data structures such as categorial data, multidimensional and high dimensional data, data in imaging, data with serial dependencies
- analyse practical statistical problems in a mathematically accurate way with the techniques and models learned on the one hand and via computer simulations on the other hand;
- are able to mathematically analyse resampling methods and apply them purposively;
- are familiar with concepts of large scale computational statistical techniques;
- are familiar with advanced tools of non-parametric statistics and empirical process theory;
- independently become acquainted with a current topic of statistical data science;
- evaluate complex statistical methods and enhance them in a problem-oriented way.

Core skills:

After having successfully completed the module, students will be able to

- handle methods and concepts of the area ""Statistical foundations of data science" confidently;
- explain complex issues of the area ""Statistical foundations of data sciencee";
- apply methods of the area ""Statistical foundations of data science" to new problems in this area.

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Workload:

Attendance time:

84 h

Self-study time:

186 h

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Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3347.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Statistical foundations of data science"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3147
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3147 "Introduction to statistical foundations of data science"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Modul B.Phi.01: Basismodul Theoretische Philosophie** *English title: Basic Studies in Theoretical Philosophy*	9 C 4 SWS
Lernziele/Kompetenzen: 1. In einem Einführungskurs (Vorlesung oder Einführungsseminar) erwerben die Studierenden Kenntnis zentraler Themen, Grundbegriffe und Theorieansätze der Theoretischen Philosophie in ihren Disziplinen Erkenntnistheorie, Wissenschaftsphilosophie, Sprachphilosophie oder Metaphysik. 2. In einem Proseminar erlangen die Studierenden grundlegende Fähigkeiten, sich mit Sachfragen der theoretischen Philosophie begrifflich präzise und argumentativ auseinanderzusetzen, insbesondere: ausgewählte Problembereiche und systematische Überlegungen der theoretischen Philosophie adäquat darzustellen, Argumentationen zu analysieren und auf elementarem Niveau in mündlicher und mindestens in Textform zu diskutieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 214 Stunden
Lehrveranstaltung: 1. Einführungskurs in die theoretische Philosophie (Vorlesung, Seminar) *Angebotshäufigkeit:* Einführungskurs bevorzugt im Wintersemester	2 SWS
Prüfung: Klausur (45 Minuten), unbenotet **Prüfungsanforderungen:** Verständnis zentraler Begriffe, Probleme und Theorieansätze der theoretischen Philosophie und Fähigkeit, diese auf elementarem Niveau argumentativ verständlich darzulegen.	2 C
Lehrveranstaltung: 2. Proseminar zur theoretischen Philosophie **Es muss eine der nachfolgenden Prüfungsformen (Klausur, Hausarbeit oder Essays) absolviert werden.**	2 SWS
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme an einem Proseminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Verständnis zentraler Begriffe, Probleme und Theorieansätze der theoretischen Philosophie. Darstellung und Diskussion von Themen der theoretischen Philosophie auf elementarem Niveau mindestens in Textform.	7 C
Prüfung: Essays (insgesamt max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme an einem Proseminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Verständnis zentraler Begriffe, Probleme und Theorieansätze der theoretischen Philosophie. Darstellung und Diskussion von Themen der theoretischen Philosophie auf elementarem Niveau mindestens in Textform.	7 C

Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** regelmäßige Teilnahme an einem Proseminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Verständnis zentraler Begriffe, Probleme und Theorieansätze der theoretischen Philosophie. Darstellung und Diskussion von Themen der theoretischen Philosophie auf elementarem Niveau mindestens in Textform.	7 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Christian Beyer
Angebotshäufigkeit: jedes Semester; Einführungskurs bevorzugt im Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 3
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Phi.02: Basismodul Praktische Philosophie** *English title: Basic Studies in Practical Philosophy*	9 C 4 SWS

Lernziele/Kompetenzen: 1. In einem Einführungskurs (Vorlesung oder Einführungsseminar) erwerben die Studierenden Kenntnis zentraler Probleme, Grundbegriffe und Theorieansätze der Praktischen Philosophie. Sie überschauen die Teilgebiete, kennen typische Themen und Terminologien sowie einige der wichtigsten Theorieansätze in Grundzügen. 2. In einem Proseminar (Basisseminar) erlangen die Studierenden grundlegende Fähigkeiten, sich mit Sachfragen der Praktischen Philosophie begrifflich präzise und argumentativ auseinander zu setzen, insbesondere: Grundprobleme und -positionen adäquat darzustellen, ethische Argumentationen zu analysieren und auf elementarem Niveau in mündlicher und mindestens in Textform zu diskutieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 214 Stunden

Lehrveranstaltung: Einführungskurs in die Praktische Philosophie (Vorlesung, Seminar) *Angebotshäufigkeit:* jedes Semester; Einführungskurs bevorzugt im Wintersemester	2 SWS
Prüfung: Klausur (45 Minuten), unbenotet **Prüfungsanforderungen:** Verständnis zentraler Begriffe, Probleme und Theorieansätze der praktischen Philosophie und Fähigkeit, diese auf elementarem Niveau argumentativ verständlich darzulegen.	2 C

Lehrveranstaltung: Proseminar zur Praktischen Philosophie **Es muss <u>eine</u> der nachfolgenden Prüfungsformen (Klausur, Hausarbeit oder Essays) absolviert werden.**	2 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** regelmäßige Teilnahme an einem Proseminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Verständnis zentraler Begriffe, Probleme und Theorieansätze der praktischen Philosophie. Darstellung und Diskussion von Themen der praktischen Philosophie auf elementarem Niveau mindestens in Textform.	7 C
Prüfung: Essays (insgesamt max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme an einem Proseminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Verständnis zentraler Begriffe, Probleme und Theorieansätze der praktischen Philosophie. Darstellung und Diskussion von Themen der praktischen Philosophie auf elementarem Niveau mindestens in Textform.	7 C
Prüfung: Hausarbeit (max. 15 Seiten)	7 C

Prüfungsvorleistungen: regelmäßige Teilnahme an einem Proseminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Verständnis zentraler Begriffe, Probleme und Theorieansätze der praktischen Philosophie. Darstellung und Diskussion von Themen der praktischen Philosophie auf elementarem Niveau mindestens in Textform.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Holmer Steinfath
Angebotshäufigkeit: jedes Semester, Einführungskurs bevorzugt im Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 3
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Phi.03: Basismodul Geschichte der Philosophie** *English title: Basic Studies in History of Philosophy*	9 C 4 SWS
Lernziele/Kompetenzen: 1. In einem Einführungskurs (Vorlesung oder Einführungsseminar) erwerben die Studierenden einen Überblick über Epochen der Philosophiegeschichte, sie machen eine erste Bekanntschaft mit jeweils zentralen Themenbereichen und einzelnen klassischen Werken. 2. In einem Proseminar (Basisseminar) erlangen die Studierenden Verständnis klassischer Texte der Philosophie sowie Grundfertigkeiten der Analyse eines Textes unter historischen und systematischen Gesichtspunkten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 214 Stunden
Lehrveranstaltung: 1. Einführungskurs in die Geschichte der Philosophie (Vorlesung, Seminar)	2 SWS
Prüfung: Klausur (45 Minuten), unbenotet **Prüfungsanforderungen:** Überblick über Epochen der Philosophiegeschichte und elementares Verständnis zentraler Themen und klassischer philosophischer Texte sowie Fähigkeit, diese auf elementarem Niveau argumentativ verständlich darzulegen.	2 C
Lehrveranstaltung: 2. Proseminar zur Geschichte der Philosophie **Es muss <u>eine</u> der nachfolgenden Prüfungsformen (Klausur, Hausarbeit oder Essays) absolviert werden.**	2 SWS
Prüfung: Essays (insgesamt max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme an einem Proseminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Überblick über Epochen der Philosophiegeschichte, elementares Verständnis zentraler Themen und klassischer philosophischer Texte. Darstellung und Diskussion philosophiegeschichtlicher Themen auf elementarem Niveau mindestens in Textform.	7 C
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** regelmäßige Teilnahme an einem Proseminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Überblick über Epochen der Philosophiegeschichte, elementares Verständnis zentraler Themen und klassischer philosophischer Texte. Darstellung und Diskussion philosophiegeschichtlicher Themen auf elementarem Niveau mindestens in Textform.	7 C
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme an einem Proseminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.)	7 C

Prüfungsanforderungen: Überblick über Epochen der Philosophiegeschichte, elementares Verständnis zentraler Themen und klassischer philosophischer Texte. Darstellung und Diskussion philosophiegeschichtlicher Themen auf elementarem Niveau mindestens in Textform.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Sebastian Bender
Angebotshäufigkeit: jedes Semester; Einführungskurs bevorzugt im SoSe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2 - 3
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Phi.05: Aufbaumodul Theoretische Philosophie** *English title: Advanced Studies in Theoretical Philosophy*	10 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden verfügen über fortgeschrittene Kenntnisse ausgewählter Themen und Theorien der theoretischen Philosophie sowie über die Fähigkeit der Darstellung und Diskussion systematischer Positionen und Probleme in mündlicher und mindestens in Textform.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 244 Stunden

Lehrveranstaltung: 1. Vorlesung oder Seminar zur theoretischen Philosophie	2 SWS
Lehrveranstaltung: 2. Seminar zur theoretischen Philosophie **Zu beiden Lehrveranstaltungen ist je eine Prüfung zu wählen**, entweder die kleine Leistung oder **eine** Modulprüfung in Form einer Hausarbeit, von Essays oder einer Klausur. In welcher Lehrveranstaltung die Prüfung in Form einer kleinen Leistung abgelegt wird und in welcher in Form einer Hausarbeit, von Essays **oder** einer Klausur, ist frei wählbar.	2 SWS
Prüfung: Kleine Leistung (max. 2 Seiten), unbenotet **Prüfungsvorleistungen:** regelmäßige Teilnahme, sofern Seminar **Prüfungsanforderungen:** Eingehende Kenntnis ausgewählter Probleme und Theorien der theoretischen Philosophie und Fähigkeit, diese mindestens in kurzer Textform argumentativ verständlich darzulegen.	3 C
Prüfung: Essays (insgesamt max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme, sofern Seminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Eingehende Kenntnis ausgewählter Probleme und Theorien der theoretischen Philosophie. Sachgemäße u. differenzierte Erörterung von Themen der theoretischen Philosophie mindestens in Textform.	7 C
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme, sofern Seminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Eingehende Kenntnis ausgewählter Probleme und Theorien der theoretischen Philosophie. Sachgemäße u. differenzierte Erörterung von Themen der theoretischen Philosophie mindestens in Textform.	7 C
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** regelmäßige Teilnahme, sofern Seminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.)	7 C

Prüfungsanforderungen: Eingehende Kenntnis ausgewählter Probleme und Theorien der theoretischen Philosophie. Sachgemäße u. differenzierte Erörterung von Themen der theoretischen Philosophie mindestens in Textform.	

Zugangsvoraussetzungen: B.Phi.01	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Misselhorn
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2 - 5
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Phi.06: Aufbaumodul Praktische Philosophie** *English title: Advanced Studies in Practical Philosophy*	10 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden verfügen über fortgeschrittene Kenntnisse ausgewählter Themen und Theorien der Praktischen Philosophie sowie über die Fähigkeit der Darstellung und Diskussion systematischer Positionen und Probleme in mündlicher und mindestens in Textform.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 244 Stunden
Lehrveranstaltung: 1. Vorlesung oder Seminar zur praktischen Philosophie	2 SWS
Lehrveranstaltung: 2. Seminar zur praktischen Philosophie **Zu beiden Lehrveranstaltungen ist je eine Prüfung zu wählen**, entweder die kleine Leistung oder **eine** Modulprüfung in Form einer Hausarbeit, von Essays oder einer Klausur. In welcher Lehrveranstaltung die Prüfung in Form einer kleinen Leistung abgelegt wird und in welcher in Form einer Hausarbeit, von Essays **oder** einer Klausur, ist frei wählbar.	2 SWS
Prüfung: Kleine Leistung (max. 2 Seiten), unbenotet **Prüfungsvorleistungen:** regelmäßige Teilnahme, sofern Seminar **Prüfungsanforderungen:** Eingehende Kenntnis ausgewählter Probleme und Theorien der praktischen Philosophie und Fähigkeit, diese mindestens in kurzer Textform argumentativ verständlich darzulegen.	3 C
Prüfung: Essay (insgesamt max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme, sofern Seminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Eingehende Kenntnis ausgewählter Probleme und Theorien der praktischen Philosophie. Sachgemäße u. differenzierte Erörterung von Themen der praktischen Philosophie mindestens in Textform.	7 C
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme, sofern Seminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Eingehende Kenntnis ausgewählter Probleme und Theorien der praktischen Philosophie. Sachgemäße u. differenzierte Erörterung von Themen der praktischen Philosophie mindestens in Textform.	7 C
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** regelmäßige Teilnahme, sofern Seminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.)	7 C

Prüfungsanforderungen: Eingehende Kenntnis ausgewählter Probleme und Theorien der praktischen Philosophie. Sachgemäße u. differenzierte Erörterung von Themen der praktischen Philosophie mindestens in Textform.	

Zugangsvoraussetzungen: B.Phi.02	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Holmer Steinfath
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2 - 5
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Phi.07: Aufbaumodul Geschichte der Philosophie** *English title: Advanced Studies in History of Philosophy*	10 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden verfügen über fortgeschrittene Kenntnisse klassischer Texte aus unterschiedlichen Epochen sowie über die Fähigkeit der Darstellung und Behandlung klassischer philosophischer Positionen und Probleme unter historischen und systematischen Gesichtspunkten in mündlicher und mindestens in Textform. Sie können philosophiehistorische Texte hinsichtlich ihrer Struktur analysieren, ihre wesentlichen Aussagen und Argumente erfassen und in ihren historischen und systematischen Interpretationsrahmen einordnen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 244 Stunden
Lehrveranstaltung: 1. Vorlesung oder Seminar zur Geschichte der Philosophie	2 SWS
Lehrveranstaltung: 2. Seminar zur Geschichte der Philosophie **Zu beiden Lehrveranstaltungen ist je eine Prüfung zu wählen**, entweder die kleine Leistung oder **eine** Modulprüfung in Form einer Hausarbeit, von Essays oder einer Klausur. In welcher Lehrveranstaltung die Prüfung in Form einer kleinen Leistung abgelegt wird und in welcher in Form einer Hausarbeit, von Essays **oder** einer Klausur, ist frei wählbar.	2 SWS
Prüfung: Kleine Leistung (max. 2 Seiten), unbenotet **Prüfungsvorleistungen:** regelmäßige Teilnahme, sofern Seminar **Prüfungsanforderungen:** Eingehende Kenntnisse klassischer philosophischer Texte aus unterschiedlichen Epochen und Fähigkeit, philosophiegeschichtliche Themen mindestens in kurzer Textform argumentativ verständlich darzulegen.	3 C
Prüfung: Essays (insgesamt max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme, sofern Seminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Eingehende Kenntnisse klassischer philosophischer Texte aus unterschiedlichen Epochen. Sachgemäße u. differenzierte Erörterung von philosophiegeschichtlichen Themen mindestens in Textform.	7 C
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme, sofern Seminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Eingehende Kenntnisse klassischer philosophischer Texte aus unterschiedlichen Epochen. Sachgemäße u. differenzierte Erörterung von philosophiegeschichtlichen Themen mindestens in Textform.	7 C
Prüfung: Klausur (120 Minuten)	7 C

Prüfungsvorleistungen: regelmäßige Teilnahme, sofern Seminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:** Eingehende Kenntnisse klassischer philosophischer Texte aus unterschiedlichen Epochen. Sachgemäße u. differenzierte Erörterung von philosophiegeschichtlichen Themen mindestens in Textform.	

Zugangsvoraussetzungen: B.Phi.03	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Sebastian Bender
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2 - 5
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Phi.18a: Vertiefte Bearbeitung philosophischer Themen für Studierende aller Fächer** *English title: Detailed Philosophical Studies*	6 C 2 SWS
Lernziele/Kompetenzen: Studierende aller Fächer erweitern ihre fachlichen Kompetenzen durch ausgewählte Themen mit allgemein philosophischem Charakter z.B. aus den Gebieten der Erkenntnis- und Wissenschaftstheorie, der Sprachphilosophie, der Ethik und der Politischen Philosophie. Die Studierenden besitzen die Fähigkeit, • die wesentlichen Aussagen und Argumente in philosophischen Texten zu erfassen, • über philosophische Probleme mit wissenschaftlicher Präzision nachzudenken und • philosophische Positionen auf der Basis aktueller Fachliteratur unter Abwägung der relevanten Thesen und Argumente mindestens in Textform darzustellen und zu diskutieren.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden
Lehrveranstaltung: Vorlesung, Proseminar, Seminar oder Hauptseminar Es muss **eine** der nachfolgenden Prüfungsformen (Hausarbeit oder Essay) absolviert werden.	
Prüfung: Essays (insgesamt max. 15 Seiten) **Prüfungsvorleistungen:** kleinere Leistung mindestens in Textform (max. 2 Seiten)	6 C
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsvorleistungen:** kleinere Leistung mindestens in Textform (max. 2 Seiten)	6 C
Prüfungsanforderungen: Verständnis zentraler Begriffe, Probleme und Theorieansätze auf einem Gebiet der Philosophie. Darstellung und Diskussion ausgewählter Probleme mindestens in Textform.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Bei Seminaren und Hauptseminaren: hinreichende Vorkenntnisse auf dem jeweiligen Gebiet (ggf. nach Rücksprache mit den Dozierenden)
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Christian Beyer
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 6
Maximale Studierendenzahl:	

nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.Phi.19a: Spezielle Themen der Philosophie für Studierende aller Fächer** *English title: Special Philosophical Topics*	3 C 2 SWS

Lernziele/Kompetenzen: Studierende aller Fächer erweitern ihre fachlichen Kompetenzen durch ausgewählte Themen mit allgemein philosophischem Charakter z.B. aus den Gebieten der Erkenntnis- und Wissenschaftstheorie, der Sprachphilosophie, der Ethik und der Politischen Philosophie. Die Studierenden besitzen die Fähigkeit, • die wesentlichen Aussagen und Argumente in philosophischen Texten zu erfassen, • über philosophische Probleme mit wissenschaftlicher Präzision nachzudenken und • philosophische Positionen in knapper Form mündlich und mindestens in Textform zu präsentieren und zu diskutieren.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Vorlesung, Proseminar, Seminar oder Hauptseminar	
Prüfung: Referat (ca. 20 Min.) mit Ausarbeitung mindestens in Textform (max. 3 Seiten) oder Essay (max. 3 Seiten) oder Klausur (45 Minuten), unbenotet **Prüfungsanforderungen:** Verständnis zentraler Begriffe, Probleme und Theorieansätze auf einem Gebiet der Philosophie. Fähigkeit zur strukturierten Darstellung und Diskussion eines eng umgrenzten Themas.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Bei Seminaren und Hauptseminaren: hinreichende Vorkenntnisse auf dem jeweiligen Gebiet (ggf. nach Rücksprache mit den Dozierenden)
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Misselhorn
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 6
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Module B.Phy.1551: Introduction to Astrophysics**	8 C 6 WLH
Learning outcome, core skills: After successful completion of the module students are familiar with the basic concepts of astrophysics in observation and theory. In particular, they • have gained an overview of observational techniques in astronomy • understand the basic physics of the formation, structure and evolution of stars and planets have learned about the classification and structure of normal and active galaxies • understand the basic physics of homogeneous cosmology and cosmological structure formation	**Workload:** Attendance time: 84 h Self-study time: 156 h

Course: Lecture and exercises for introduction to astrophysics	
Examination: oral (approx. 30 minutes) or written (120 min.) exam **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully. **Examination requirements:** Observational techniques, Planets and exoplanets, planet formation, stellar formation, structure and evolution, galaxies, AGN and quasars, cosmology, structure formation	8 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Jens Carsten Niemeyer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1
Maximum number of students: 120	

Georg-August-Universität Göttingen **Modul B.Phy.5601: Theoretical and Computational Neuroscience I** *English title: Theoretical and Computational Neuroscience I*	3 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • ein vertieftes Verständnis folgender Themen entwickelt haben: TCN I: biophysikalische Grundlagen neuronaler Anregbarkeit, mathematische Grundlagen neuronaler Anregbarkeit, Input-Output Beziehungen und Bifurkationen, Klassifizierung, Existenz, Stabilitaet und Koexistenz sychroner und asynchroner Zustaende in spikenden neuronalen Netzwerken; • Methoden und Methodenentwicklung für die Analyse hochdimensionaler Modelle ratenkodierter Einheiten in Feldmodellen verstehen; • die Handhabung von Bifurkationsszenarien und zugehörigen Instabilitäten verstanden haben.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Collective Dynamics Biological Neural Networks I (Vorlesung)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	3 C
Prüfung: Mündlich Mündliche Prüfung (ca. 30 Minuten)	3 C
Prüfung: Vortrag (2 Wochen Vorbereitungszeit) (30 Minuten)	3 C

Prüfungsanforderungen: Grundlagen der Membranbiophysi;, Bifurkationen anregbarer Systeme; Verständnis der Grundlagen der Modellierungsansätze der Neurophysik; kollektive Zustände spikender neuronaler Netzwerke; insbesondere Synchonizität; Balanced State; Phase-Locking und diesen Zuständen unterliegenden lokalen und Netzwerkeigenschaften: Netzwerktopologie; Delays; inhibitorische und exzitatorische Kopplung; sparse random networks	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Fred Wolf
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Modul B.Phy.5602: Theoretical and Computational Neuroscience II** *English title: Theoretical and Computational Neuroscience II*	3 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten Studierende... • das vertiefte Verständnis folgender Themen entwickelt haben: TCN II: Grundlagen neuronaler Anregbarkeit, Input-Output Beziehungen bei Einzelneuronen, eindimensionale Feldmodelle (Feature Selectivity, Contrastinvariance), zweidimensionale Feldmodell (Zusammenwirken von kurz- und langreichweitigen Verbindungen sowie lokaler Nichtlinearitaeten), Amplitudengleichungen und ihre Loesungen; • Methoden und Methodenentwicklung für die Analyse spikender neuronaler Netzwerke mit und ohne Delays, Handhabung von Bifurkationsszenarien und zugehörigen Instabilitäten verstehen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Collective Dynamics Biological Neural Networks II (Vorlesung)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	3 C
Prüfung: Mündlich (ca. 30 Minuten)	3 C
Prüfung: Seminarvortrag (2 Wochen Vorbereitungszeit) (30 Minuten)	3 C

Prüfungsanforderungen: Ratenmodelle von Einzelneuronen; Feldansatz in der theoretischen Neurophysik; Grundlagen der Bifurkationen anregbarer System; Verständnis der Grundlagen der Modellierungsansätze der Neurophysik; Zusammenhang diskrete/kontinuierliche Modelle; kollektive Zustände ein- und zweidimensionaler Feldmodelle, insbesondere ring model of feature selectivity; orientation preference maps.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Fred Wolf
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Module B.Phy.5651: Advanced Computational Neuroscience**	3 C 2 WLH

Learning outcome, core skills: Participants in the course can explain and relate biological foundations and mathematical modelling of selected (neuronal) algorithms for learning and pattern formation. Based on the the algorithms' properties, they can discuss and derive possible technical applications (robots).	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced Computational Neuroscience I (Lecture)	
Examination: Written examination (90 Min.) or oral examination (approx. 20 Min.) **Examination requirements:** Algorithms for learning: • Unsupervised Learning (Hebb, Differential Hebb), • Reinforcement Learning, • Supervised Learning Algorithms for pattern formation. Biological motivation and technical Application (robots).	3 C

Admission requirements: none	**Recommended previous knowledge:** Basics Computational Neuroscience
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

Additional notes and regulations: Hinweis: Die B.Phy.5652 kann als vorlesungsbegleitendes Praktikum besucht werden.

Georg-August-Universität Göttingen Module B.Phy.5652: Advanced Computational Neuroscience II	3 C 2 WLH
Learning outcome, core skills: Participants in the course can implement, test, and evaluate the properties of selected (neuronal) algorithms for learning and pattern formation.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced Computational Neuroscience II	
Examination: 4 Protocols (max. 3 Pages) and Presentations (ca. 10 Min.), not graded **Examination requirements:** Algorithms for learning: • Unsupervised Learning (Hebb, Differential Hebb), • Reinforcement Learning, • Supervised Learning Algorithms for pattern formation. Biological motivation and technical Application (robots). *For each of the 4 programming assignments 1 protocol (ca. 3 pages) and 1 oral presentations (demonstration and discussion of the program, ca. 10 min).*	3 C

Admission requirements: B.Phy.5651 (can be taken in parallel to B.Phy.5652)	**Recommended previous knowledge:** Programming in C++, basic numerical algorithms, Grundlagen Computational Neuroscience B.Phy.5504: Computational Physics (Scientific Computing)
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 24	

Georg-August-Universität Göttingen Module B.Phy.5676: Computer Vision and Robotics	9 C 6 WLH

Learning outcome, core skills: After successful completion of this module, students are familiar with • the basic concepts of computer vision (CV), • low level hardware components and their functions, • building and programming a robot, and • computer vision and robotics algorithms.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Introduction to Computer Vision and Robotics (Lecture) *Contents*: On-Off Controller, PID Controller, Moving Average Filter, Exponential Moving Average Filter, Kalman Filter, A*, Dijkstra, RRT, Q-Learning , Inverse and Forward Kinematics, Movement Generation Methods, Smoothing and Median Filtering, Bilateral Filtering, Non-Local Means, Connected Components , Morphological Operators , Line Detection, Circle Detection, Feature Detection, Advanced image segmentation algorithms.	2 WLH
Course: Practical Course on Computer Vision and Robotics (Lecture) *Contents*: Building a robot, solving a graph problem using the robot and executing the found solution by the robot in a real-world scenario involving perception and navigation	2 WLH
Course: Tutorial on Computer Vision and Robotics (Tutorial) *Contents*: In the accompanying tutorial sessions students deepen and broaden their knowledge from the lectures	2 WLH
Examination: Written report (approx. 10 p.) and Oral Exam (approx. 30 minutes) **Examination requirements:** Written report requirements: The students must be able • to describe their project in a written report • to explain given problems and used solutions for navigation- and perception problems of robots Oral Examination requirements: The students must be able • to repeat and explain lecture material • to explain control algorithms for a robot, and • to identify and understand low level hardware components as robot sensors and actuators.	9 C

Admission requirements: none	**Recommended previous knowledge:** Programming in Python
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

three times	Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 24	

Georg-August-Universität Göttingen **Modul B.WIWI-BWL.0023: Grundlagen der Versicherungstechnik** *English title: Actuarial Techniques*	6 C 2 SWS

Lernziele/Kompetenzen: Die Studierenden erwerben die folgenden Fähigkeiten und Kenntnisse: • Kenntnis und Verständnis der Funktionsweise der Versicherungsmärkte, • Kenntnis und Verständnis der Geschäftsmodelle und der technischen Grundlagen in der Lebens-, Kranken-, Schadens- und Rückversicherung sowie in der Betrieblichen Altersversorgung, • Kenntnis und Verständnis des Risikomanagements und der Solvabilitätsvorschriften incl. Methoden der Risikobewertung, • Kenntnis und Verständnis der Finanzierungsvorgänge incl. Rückstellungsbildung in der Versicherungswirtschaft, • Fähigkeit, der Bewertung der zentralen Unterschiede in den Geschäftsmodellen der privaten Versicherungswirtschaft, der gesetzlichen Versicherungssysteme und der Kreditwirtschaft, • Kenntnis des Instrumentariums der Risikopolitik eines Versicherungsunternehmens, auch anhand konkreter praktischer Beispiele, • Fähigkeit, einfache Berechnungen zur Versicherungstechnik vorzunehmen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

Lehrveranstaltung: Grundlagen der Versicherungstechnik (Vorlesung) *Inhalte*: 1. Begriffsbestimmungen, Struktur und Elemente des Risikotransfers; 2. Elemente der Risikopolitik (u.a. Grundlagen der Prämienkalkulation und -differenzierung, Risikoauslese und Underwriting, Reservierungspolitik, Schadenmanagement, Rück- und Mitversicherung,); 3. Geschäftsmodelle der Versicherungssparten (Lebensversicherung, Krankenversicherung, Schadenversicherung, Rückversicherung); 4. Risikomanagement und Solvabilitätsvorschriften, insbesondere Solvency II; 5. Finanzierung und Kapitalanlage	2 SWS
Prüfung: Klausur (120 Minuten)	6 C

Prüfungsanforderungen: • Nachweis von Kenntnissen der Funktion eines Versicherungsmarktes und seiner wesentlichen Determinanten und Begriffe, • Nachweis von Kenntnissen im Risikomanagement, der Solvabilitätsanforderungen und Risikobewertung, • Nachweis von Kenntnissen der Risikopolitik und der Geschäftsmodelle der Versicherungssparten, • Nachweis von Kenntnissen der Finanzierung des Risikotransfers, • Bewertung der Rolle der Versicherungswirtschaft zum Markt der Kreditwirtschaft und der gesetzlichen Versicherungssysteme, • Einfache Berechnungen zur Versicherungstechnik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Martin Balleer
Angebotshäufigkeit: in der Regel jedes zweite Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.WIWI-BWL.0038: Supply Chain Management** *English title: Supply Chain Management*	6 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreicher Teilnahme des Moduls sind die Studierenden in der Lage, Instrumente, mit denen Distributionsaufgaben von Industrie- und Handelsunternehmen gelöst und koordiniert werden, anzuwenden, zu beurteilen und bei Bedarf anzupassen. Hierzu zählen insbesondere die gemeinsame Prognose der Nachfrage sowie die koordinierte Bestell- und Bestandspolitik von Handel und Industrie.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

Lehrveranstaltung: Supply Chain Management (Vorlesung) *Inhalte*: 1. Begriffliche Grundlagen des Supply Chain Managements 2. Analyserahmen für die Ausgestaltung der Supply Chain • Der Management-Zyklus • Elemente und Strukturen des entscheidungsorientierten Ansatzes • Entscheidungsfelder des Supply Chain Managements • Zielgrößen des Supply Chain Managements • Analyse der Einflussfaktoren 3. Koordination der Supply Chain • Begriffliche Grundlagen • Transaktionale versus relationale Koordination • Supplier Relationship Management • Beziehungsstile im Business to Business Geschäft 4. Standortplanung • Ziele, Einflussfaktoren und Optionen der Lagerstruktur • Methoden zur Lösung von Standortproblemen 5. Prognose der Nachfrage • Elemente eines Prognosesystems • Regressionsanalyse im Rahmen der Kausalanalyse • Grundlagen der Zeitreihenanalyse • Exponentielle Glättung Saisonmodell 6. Bestellmengenplanung • Bestellentscheidungen bei deterministischer Nachfrage • Bestellentscheidungen bei stochastischer Nachfrage • Das Joint Economic Lot Size (JELS) Modell 7. Technologische Voraussetzungen • Elektronischer Datenaustausch • Standardisierung • RFID	2 SWS

Prüfung: Klausur (90 Minuten)	6 C
Prüfungsanforderungen: Nachweis von Fähigkeiten, Probleme der wirtschaftsstufenübergreifenden Koordination von Beschaffungs- und Distributionsproblemen zu analysieren. Beherrschung von Instrumenten, mit denen insbesondere die Schnittstelle zwischen Industrie und Handel abgestimmt wird. Kritische Diskussion der Ergebnisse solcher Instrumente.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-BWL.0005 Marketing
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Waldemar Toporowski
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Je nach Kapazität findet eine zusätzliche Übung mit Fallstudien statt. Informationen dazu stehen zu Beginn des Semesters im Vorlesungsverzeichnis.

Georg-August-Universität Göttingen **Module B.WIWI-BWL.0087: International Marketing**	6 C 2 WLH
Learning outcome, core skills: After successful attendance the students understand the foundations of international marketing as well as the diverse environments of global markets. They are able to explain and the central elements of the international decision-making process, such as country and entry mode selection. Moreover, they are able to analyze and compare the attractiveness of different countries and recommend tailored marketing program strategies.	**Workload:** Attendance time: 28 h Self-study time: 152 h
Course: International Marketing (Lecture) *Contents*: • Introduction to international marketing • Social and cultural environments • Political, legal, and regulatory environments • Assessing global marketing opportunities • International marketing strategy (country selection, entry-modes, international marketing mix) • Branding across cultures The course conveys theoretical knowledge which is enriched by case studies. Specific contents are international trade developments, culture and values (incl. approaches by Hofstede, Inglehart, & Schwartz), political risk assessment, legal environments, international marketing research, competitive analysis and strategy (incl. Porter's Five Forces), emerging markets, entry strategy (incl. Uppsala model vs. born global approach), country selection, market entry modes, international marketing mix, and the country-of-origin effect.	2 WLH
Examination: Written examination (90 minutes)	6 C
Examination requirements: The written exam assesses students' understanding of the course content as well as their ability to apply their knowledge to case studies. **Examples:** • Comparing different approaches of cultural difference assessment • Assessing a country's competitive environment • Recommending entry modes for different countries	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Yasemin Boztug
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

twice	3 - 6
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Modul B.WIWI-VWL.0001: Mikroökonomik II** *English title: Microeconomics II*	6 C 5 SWS
Lernziele/Kompetenzen: Nach erfolgreicher Absolvierung der Veranstaltung sind Studierende in der Lage: • verschiedene Marktformen voneinander zu unterscheiden und deren Wohlfahrtseffekte zu analysieren, • zwischen der Gleichgewichtsanalyse eines einzelnen Marktes und der Analyse des allgemeinen Gleichgewichts aller Märkte zu unterscheiden und selbstständig anzuwenden, • das Prinzip intertemporaler Entscheidungen der Haushalte zu verstehen und in die optimale Entscheidung der Haushalte einzubeziehen, • die grundlegenden Zusammenhänge von Risiko und Versicherungsmärkten zu verstehen und in die optimale Entscheidung der Haushalte einzubeziehen, • die Grundlagen simultaner und sequentieller Spieltheorie zu verstehen und selbstständig anzuwenden, • die Konsequenzen asymmetrischer Informationen für das Verhalten der Marktteilnehmer zu analysieren.	**Arbeitsaufwand:** Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden
Lehrveranstaltung: Mikroökonomik II (Vorlesung) *Inhalte*: • Marktgleichgewicht bei vollkommener Konkurrenz und im Monopol: Grafische Analyse des Marktgleichgewichts und der allgemeinen Wohlfahrt in Abhängigkeit von der Marktform. • Monopolistische Preisdifferenzierung: Analyse von Preis-, Mengen- und Wohlfahrtseffekten. • Allgemeines Gleichgewicht: Grafische Analyse des allgemeinen Marktgleichgewichts mithilfe der Edgeworth-Box. Definition des Gesetzes von Walras sowie des ersten und zweiten Satzes der Wohlfahrtsökonomik. • Ersparnis und Investition: Mathematische und grafische Abhandlung der intertemporalen Budgetgleichung der Haushalte sowie der optimalen Konsum- und Produktionsentscheidungen. • Risiko und Versicherung: Mathematische und grafische Analyse der Entscheidung von Haushalten unter Unsicherheit. Einführung der Erwartungsnutzenhypothese und der von-Neumann-Morgenstern-Nutzenfunktion. • Oligopoltheorie: Mathematische und grafische Analyse von Cournot-, Stackelberg- und Bertrand-Gleichgewicht. • Spieltheorie: Spiele in Normalform. Bestimmung dominanter Strategien und Nash-Gleichgewicht. Sequentielle Entscheidungen. Analyse sequentieller Spiele mithilfe des Entscheidungsbaumes. • Asymmetrische Information: Analyse des Verhaltens von Marktteilnehmern im Fall von asymmetrisch verteilter Information. Moralisches Risiko (Moral hazard) und adverse Selektion.	3 SWS

Lehrveranstaltung: Mikroökonomik II (Tutorium) *Inhalte*: In den Übungen werden die Inhalte der Vorlesung anhand von Aufgaben wiederholt und vertieft.	2 SWS
Prüfung: Klausur (90 Minuten)	6 C

Prüfungsanforderungen: • Aufgaben sind sowohl rechnerisch als auch grafisch und verbal intuitiv zu lösen, • Nachweis grundlegender Kenntnisse des Wettbewerbsgleichgewichts eines Marktes und des allgemeinen Gleichgewichts, insbesondere der Rolle des Preises für die Markträumung, • Nachweis der Fähigkeit zur grafischen und mathematischen Analyse verschiedener Marktformen und deren Wohlfahrtseffekte, • Nachweis grundlegender Kenntnisse der Spieltheorie und Oligopoltheorie und der Fähigkeit der Bestimmung der optimalen Strategie der Marktteilnehmer, • Nachweis der Fähigkeit zur Bewertung der Risikoeinstellung von Marktteilnehmern und der Konsequenzen für die optimale Entscheidung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Modul B.WIWI-OHP.0007: Mikroökonomik I
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Claudia Keser, Prof. Dr. Udo Kreickemeier, Prof. Dr. Robert Schwager, Prof. Dr. Sebastian Vollmer
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2 - 6
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.WIWI-VWL.0002: Makroökonomik II** *English title: Macroeconomics II*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden: • können die außenwirtschaftlichen Beziehungen einer Volkswirtschaft systematisch erfassen, • sind in der Lage, ein gesamtwirtschaftliches Modell durch die Beziehungen zum Ausland zu erweitern und anhand dieses Modells die Wirkung verschiedener wirtschaftspolitischer Maßnahmen in einer offenen Volkswirtschaft zu diskutieren, • kennen die Eigenschaften verschiedener Währungssysteme und können deren Vor- und Nachteile unter Einbeziehung ihres Einflusses auf die Wirkung wirtschaftspolitischer Maßnahmen beurteilen, • verstehen die wesentlichen Herausforderungen der modernen Geld- und Fiskalpolitik und können wirtschaftspolitische Entscheidungsprozesse modelltheoretisch abbilden, • sind mit den Grundlagen der Wachstumsökonomik vertraut und können das Solow-Modell zur Bewertung von langfristigen Zusammenhängen und der Analyse der Quellen des Wirtschaftswachstums heranziehen, • können Mithilfe verschiedener Modellrahmen makroökonomische Argumente nachvollziehen und selbständig analysieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Makroökonomik II (Vorlesung) *Inhalte*: Die Vorlesung erweitert die makroökonomischen Grundmodelle der Vorlesung Makroökonomik I entlang drei Dimensionen. Einerseits wird die Annahme einer geschlossenen Volkswirtschaft gelockert und die makroökonomischen Prozesse um Außenhandel und Wechselkursdynamiken in einer offenen Volkswirtschaft erweitert. In diesem Kontext werden auch unterschiedliche Wechselkurssysteme diskutiert und die Auswirkungen wirtschaftspolitischer Interventionen analysiert. Des Weiteren werden ausgewählte wirtschaftspolitische Fragestellungen vertiefend analysiert, insbesondere die Interaktionen zwischen wirtschaftspolitischen Entscheidungsträgern und Wirtschaftsakteuren, sowie ausgewählte Fragestellungen der Fiskal- und Geldpolitik. Die Makroökonomik der langen Frist wird durch eine Einführung in die Wachstumstheorie analysiert, wobei insbesondere die Quellen volkswirtschaftlichen Wachstums modelltheoretisch dargestellt werden.	2 SWS
Lehrveranstaltung: Makroökonomik II (Übung) *Inhalte*: Im Rahmen der begleitenden Übung/Tutorium vertiefen die Studierenden die Kenntnisse aus der Vorlesung anhand ausgewa¨hlter theoretischer Fragestellungen und üben die eigenständige Anwendung von Modellen.	2 SWS
Prüfung: Klausur (90 Minuten)	6 C
Prüfungsanforderungen:	

• Nachweis von Kenntnissen über die systematische Erfassung der außenwirtschaftlichen Beziehungen einer Volkswirtschaft und von Kenntnissen über deren Bedeutung für die Analyse des gesamtwirtschaftlichen Gleichgewichts und wirtschaftspolitischer Maßnahmen, • Nachweis von Kenntnissen über verschiedene Wechselkurssysteme und deren Bedeutung für die Analyse des gesamtwirtschaftlichen Gleichgewichts und wirtschaftspolitischer Maßnahmen, • Nachweis von Kenntnissen über ausgewählte vertiefende Fragen der Fiskal- und Geldpolitik, • Nachweis von Kenntnissen des Grundmodells der Wachstumsökonomik und volkswirtschaftlicher Zusammenhänge in der langen Frist, • die Studierenden zeigen, dass sie in der Lage sind, mit verschiedenen gesamtwirtschaftlichen Modellen analytisch und grafisch zu arbeiten, die dahinterstehenden Annahmen zu reflektieren sowie die sich ergebenden Unterschiede hinsichtlich der Wirkung wirtschaftspolitischer Maßnahmen darstellen und kritisch würdigen zu können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-OPH.0008 Makroökonomik I
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Tino Berger, Prof. Dr. Andreas Fuchs, Prof. Dr. Krisztina Kis-Katos, Dr. Katharina Werner
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2 - 6
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.WIWI-VWL.0005: Grundlagen der internationalen Wirtschaftsbeziehungen** *English title: Foundations of International Economic Relations*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden: • kennen verschiedene Ursachen für die Teilnahme eines Landes an der internationalen Arbeitsteilung, • können verschiedene Ursachen für den relativen Preisvorteil eine Landes theoretisch fundieren und deren wirtschaftspolitische Konsequenzen darstellen, • sind mit den Wohlfahrtswirkungen von Außenhandel vertraut und können deren gesellschaftlichen Folgen reflektieren, • kennen mögliche staatliche Instrumente zur Beeinflussung von Im- und Exporten und können die sich daraus ergebenden gesellschaftlichen Konsequenzen einzelstaatlich und weltwirtschaftlich bewerten, • sind mit den Voraussetzungen und den Motiven einer multinationalen Unternehmertätigkeit vertraut, • haben einen Überblick über die verschiedenen Erscheinungsformen von Devisenmärkten und den Motiven der dort handelnden Akteure und können die dabei bestehenden Zusammenhänge darstellen, • sind vertraut mit verschiedenen Determinanten von Wechselkursen und können deren Relevanz kritisch reflektieren, • verstehen die Auswirkungen von Wechselkursveränderungen für eine Volkswirtschaft, • sind vertraut mit verschiedenen Wechselkursregimen und deren spezifischen Eigenschaften.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Grundlagen der internationalen Wirtschaftsbeziehungen (Vorlesung) *Inhalte*: Die Vorlesung besteht aus zwei Teilen. Teil 1 gibt einen Überblick über die Ursachen und die Folgen der internationalen Arbeitsteilung. Dabei werden verschiedene Theorien des Internationalen Handels analysiert und deren volkswirtschaftliche Konsequenzen dargestellt. Auch die Gründe für staatliche Interventionen in den Welthandel sowie deren ökonomische Konsequenzen werden analysiert. In Teil 2 werden die verschiedenen Erscheinungsformen von Devisenmärkten und die dort praktizierten Geschäfte untersucht und die Bestimmungsfaktoren von Wechselkursen diskutiert und theoretisch vertieft. Darüber hinaus wird die Validität der Theorien mittels empirischer Studien überprüft.	2 SWS
Lehrveranstaltung: Grundlagen der internationalen Wirtschaftsbeziehungen (Übung) *Inhalte*: Im Rahmen der begleitenden Übung vertiefen die Studierenden die Kenntnisse aus der Vorlesung anhand ausgewählter theoretischer Fragestellungen.	2 SWS

Prüfung: Klausur (90 Minuten)	6 C
Prüfungsanforderungen: Nachweis von: • Kenntnissen der Gründe für die internationale Arbeitsteilung sowie über Theorien zur Bestimmung relativer Preisvorteile eines Landes und über die ökonomischen Folgen des Außenhandels, • Kenntnissen über die Erscheinungsformen von Devisenmärkten und die dort praktizierten Geschäfte sowie der Bestimmungsfaktoren von Wechselkursen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-OPH.0007 Mikroökonomik I, B.WIWI-OPH.0008 Makroökonomik I
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Udo Kreickemeier
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 6
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.WIWI-VWL.0006: Wachstum und Entwicklung** *English title: Economic Growth and Development*	6 C 4 SWS
Lernziele/Kompetenzen: Nach Abschluss dieses Moduls haben die Studierenden ein grundlegendes Verständnis für die Ursachen und Konsequenzen von langfristigem Wirtschaftswachstum bekommen. Sie machen sich mit den Standardmodellen der Wachstumstheorie vertraut, bewerten empirische Tests dieser, ziehen wirtschaftspolitische Implikationen und reflektieren diese kritisch.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Wachstum und Entwicklung (Vorlesung) *Inhalte*: 1) Faktorakkumulation i) Kapitalakkumulation ii) Das Modell überlappender Generationen. iii) Bevölkerungswachstum und Wirtschaftswachstum iv) Der Demographische Übergang v) Humankapital: Gesundheit und Ausbildung vi) Warum fließt Kapital nicht von reichen zu armen Ländern? 2) Produktivität i) Wachstumszerlegung ii) Erfindungen und Ideen iii) Technologischer Fortschritt und Wachstum vor dem 18. Jahrhundert iv) Technologischer Fortschritt und Wachstum heute 3) Deep Determinants	2 SWS
Lehrveranstaltung: Wachstum und Entwicklung (Übung) *Inhalte*: In der begleitenden Übung sollen die Studierenden anhand von Übungsaufgaben ihr Wissen zu den in der Vorlesung behandelten Themen vertiefen und erweitern.	2 SWS
Prüfung: Klausur (90 Minuten)	6 C
Prüfungsanforderungen: Nachweis: • fundierter Kenntnisse über die Ursachen und Konsequenzen langfristiger Einkommensunterschiede, • von grundlegendem Verständnis der behandelten Wachstumsmodelle, • von der Fähigkeit zum selbstständigen Lösen von Anwendungsbeispielen im Themenbereich der Vorlesung (theoretisch, graphisch und verbal).	

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**

keine	B.WIWI-OPH.0008 Makroökonomik I B.WIWI-OPH.0006 Statistik
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Holger Strulik Dr. Katharina Werner
Angebotshäufigkeit: jedes zweite Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 6
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.WIWI-VWL.0007: Einführung in die Ökonometrie** *English title: Introduction to Econometrics*	6 C 6 SWS

Lernziele/Kompetenzen: Das Modul gibt eine umfassende Einführung in die ökonometrische Analyse ökonomischer Fragestellungen. Die Studierenden erlernen mit Hilfe der Methoden linearer Regressionsanalyse erste eigene empirische Studien durchzuführen. Die vermittelten Kompetenzen beinhalten die Spezifikation von ökonometrischen Modellen, die Modellselektion und –schätzung. Darüber hinaus werden Studierende mit ersten Problemen im Bereich der linearen Regression wie beispielsweise Heteroskedastizität und Autokorrelation vertraut gemacht. Dieses Modul bildet das Fundament für weiterführende Ökonometrie Veranstaltungen.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Einführung in die Ökonometrie (Vorlesung) *Inhalte*: 1. Einführung in lineare multiple Regressionsmodelle, Modellspezifikation, KQ-Schätzung, Prognose und Modellselektion, Multikollinearität und partielle Regression. 2. Lineares Regressionsmodell mit normalverteilten Störtermen, Maximum-Likelihood-Schätzung, Intervallschätzung, Hypothesentests 3. Asymptotische Eigenschaften des KQ- und GLS Schätzers 4. Lineares Regressionsmodell mit verallgemeinerter Kovarianzmatrix, Modelle mit autokorrelierten und heteroskedastischen Fehlertermen, Testen auf Autokorrelation und Heteroskedastizität.	2 SWS
Lehrveranstaltung: Einführung in die Ökonometrie (Übung) *Inhalte*: Die Großübung vertieft die Inhalte der Vorlesung anhand von Rechenaufgaben mit ökonomischen Fragestellungen und Datensätzen. Weiterhin werden theoretische Konzepte aus der Vorlesung detailliert hergeleitet.	2 SWS
Lehrveranstaltung: Einführung in die Ökonometrie (Tutorium) *Inhalte*: Das Tutorium vertieft die Inhalte der Vorlesung und Großübung anhand von Rechenaufgaben. Ein großer Teil beinhaltet das Schätzen von ökonometrischen Modellen mit realen Daten und mit Hilfe des Softwareprogramms Eviews.	2 SWS
Prüfung: Klausur (90 Minuten)	6 C

Prüfungsanforderungen: Die Studierenden zeigen, dass sie einfache ökonometrische Konzepte verstanden haben. Darüber hinaus sind sie in der Lage, diese auf reale wirtschaftliche Fragestellungen anzuwenden.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-OPH.0002 Mathematik B.WIWI-OPH.0006 Statistik

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Helmut Herwartz
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 5
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.WIWI-VWL.0008: Geldtheorie und Geldpolitik** *English title: Money and International Finance*	6 C 4 SWS

Lernziele/Kompetenzen: Nach erfolgreicher Absolvierung der Veranstaltung sind Studierende in der Lage: • grundlegende makroökonomische Zusammenhänge zwischen der Geldpolitik und der Realwirtschaft zu verstehen, • die Funktionen des Finanzsystems, die Bedeutung von Zinsen und der Kreditvergabe zu verstehen, • die Transmissionskanäle der Geldpolitik zu verstehen, • die klassischen und neueren Instrumente der Zentralbanken zur Durchführung der Geldpolitik zu analysieren, • die Besonderheiten der Geldpolitik in der Eurozone zu verstehen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Geldtheorie und Geldpolitik (Vorlesung) *Inhalte*: 1. Finanzmärkte 2. Finanzmarktinstitutionen 3. Zentralbanken 4. Geldtheorie	2 SWS
Lehrveranstaltung: Geldtheorie und Geldpolitik (Übung) *Inhalte*: In den Übungen werden die Inhalte der Vorlesung anhand von Aufgaben wiederholt und vertieft.	2 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Bis zu drei Einsendehausaufgaben; Länge jeweils bis zu drei maschinengeschriebenen Seiten (Bedingung zur Zulassung zur Klausur ist das Erreichen von 60% der insgesamt erreichbaren Punkte).	6 C

Prüfungsanforderungen: • Nachweis fundierter Kenntnisse der Begriffe im Bereich der Geldtheorie und Geldpolitik durch intuitive und analytische Beantwortung von Fragen, • Nachweis der Fähigkeit zur grafischen und mathematischen Analyse der Geldtheorie und Geldpolitik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-OPH.0008 Makroökonomik I
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Tino Berger
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	3 - 6
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.WIWI-VWL.0010: Einführung in die Institutionenökonomik** *English title: Foundations of Institutional Economics*	6 C 2 SWS

Lernziele/Kompetenzen: Die Studierenden: • kennen verschiedene Definitionen von internen und externen Institutionen, sowie deren Relevanz in der wirtschaftspolitischen Normsetzung, • kennen die Rolle von Eigentumsrechten und deren Durchsetzung in der ökonomischen Theorie und Praxis, • kennen Konzepte von Transaktionskosten und deren Wirkung auf die • Interaktion von Individuen und Firmen auf dem Markt, • kennen die Rolle des Staates bei der Einführung und Durchsetzung externer Institutionen, • kennen Grundlagen der Neuen Politischen Ökonomik und deren Theorie der Demokratie, Bürokratie und Interessengruppe, • kennen institutionenökonomische Analysekonzepte wie die Prinzipal-Agenten-Theorie oder Moral Hazard, sowie experimentelle Forschungsergebnisse zur Institutionenanalyse, • kennen die Rolle und den Wandel von Verhaltensmodellen als wirtschaftspolitisches Instrument.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

Lehrveranstaltung: Einführung in die Institutionenökonomik (Vorlesung) *Inhalte*: Diese Vorlesung soll die theoretischen Grundlagen der Institutionenökonomik vermitteln und verschiede (Anwendungs-)Bereiche aufzeigen**.** Die Vorlesung ist inhaltlich in drei Blöcke unterteilt. Im ersten wird die institutionenökonomische Theorie vermittelt. Dabei wird mit der Abgrenzung zwischen internen und externen Institutionen, sowie ihrer Entwicklung und Bedeutung für das gesellschaftliche Zusammenleben begonnen. Dabei wird auch auf ihre Relevanz in der wirtschaftspolitischen Normsetzung und die Durchsetzungsmechanismen eingegangen. Im Anschluss werden Verfügungsrechte als eine der zentralen externen Institutionen bezüglich Konzept und Umsetzungsform erläutert und analysiert. Die Governancestrukturen sollen mithilfe der drei Akteure Unternehmen, Markt sowie Staat und politischer Prozess vermittelt werden. Dabei werden Theorie und Anwendungsmöglichkeiten von Transaktionskosten und deren Wirkung auf die Interaktion von Individuen und Firmen erörtert. Die Prinzipal-Agenten-Theorie und Moral Hazard dienten dabei als institutionenökonomische Analysekonzepte. Zudem sind die Rolle des Staates bei der Einführung und Durchsetzung externer Institutionen, sowie die Grundlagen der Neuen Politischen Ökonomik und deren Theorien der Demokratie, Bürokratie und Interessengruppen Gegenstand der Vorlesung. Der zweite Block konzentriert sich auf kulturvergleichende Institutionenökonomik. Der Fokus liegt auf dem Varieties of Capitalism-Ansatz von Hall & Soskice. Zudem wird	2 SWS

der Zusammenhang von Institutionen mit wirtschaftlichem Wachstum und Entwicklung vermittelt. Der dritte Block thematisiert behavioral Governance und damit die Anwendungsmöglichkeiten von Institutionenökonomik. Beginnend mit der Rolle und dem Wandeln von ökonomischen Verhaltensmodellen und ihrer Relevanz für die Institutionenökonomik wird unter anderem das Verhaltensmodell des homo oeconomicus institutionalis vermittelt. Daran anschließend wird das Regulatory Choice Problem Gegenstand der Vorlesung. Zum Schluss werden das Konzept des Nudging und die bisherigen vielfältigen Anwendungen in der Politik vorgestellt und diskutiert. In diesem Block gibt es einen kurzen Einstieg in die experimentelle Ökonomik als ein Tool der institutionenökonomischen Analyse. Neben der Vermittlung der oben genannten Theorien und Konzepte ist in jeder Vorlesung Platz für die kritische Diskussion mit den Studierenden. Zur weiteren kritischen Auseinandersetzung mit dem vermittelten Inhalt werden zwei Hausaufgaben gestellt. In diesen sollen zum einen bestimmte Konzepte wiedergegeben werden und zum anderen sollen diese in den aktuellen Forschungskontext einbezogen werden.	
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Bearbeitung von zwei Hausaufgaben, von denen mindestens eine bestanden werden muss.	6 C

Prüfungsanforderungen: In der Klausur sollen die erlernten theoretischen Konzepte wiedergegeben, erklärt und kritische diskutiert bzw. reflektiert werden. Darüber hinaus müssen die Studierenden den Nachweis erbringen in der Lage zu sein diese theoretischen Konzepte auf aktuelle wirtschaftspolitische Fragestellungen anzuwenden.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-OPH.0007 Mikroökonomik I, B.WIWI-OPH.0008 Makroökonomik I
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Kilian Bizer
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 6
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.WIWI-VWL.0059: Internationale Finanzmärkte** *English title: International Financial Markets*	6 C 4 SWS
Lernziele/Kompetenzen: Nach erfolgreicher Absolvierung der Veranstaltung sind Studenten in der Lage: • grundlegende makroökonomische Zusammenhänge auf dem Devisenmarkt zu verstehen und intuitiv wiederzugeben, • das Zusammenspiel von verschiedenen Makrovariablen und ihre Wirkung auf den Wechselkurs zu verstehen, • optimale Investitionsentscheidungen der Investoren selbstständig zu ermitteln, • Bedingungen zu bewerten, unter denen Industrie- und Entwicklungsländer auf dem internationalen Finanzmarkt zusammenarbeiten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Internationale Finanzmärkte (Vorlesung) *Inhalte*: 1. Monetärer Ansatz auf lange Sicht Einfaches monetäres Modell. Die Art und Weise wie Preisanpassungen zu einem langfristigen Gleichgewicht führen. Realzins und Wechselkurs. 2. Asset-Ansatz auf kurze Sicht Kurzfristiges Gleichgewicht am Geldmarkt und am Devisenmarkt. Die Beziehung zwischen Inlandsrenditen, Auslandsrenditen und dem Wechselkurs einschließlich Überschreitung. 3. Zahlungsbilanz Bruttonationaleinkommen, Bruttoinlandsausgaben, Ersparnis und Investitionen in einer geschlossenen / offenen Wirtschaft. Leistungsbilanz und seine Komponenten. Globales Ungleichgewicht und reale Beispiele dafür. 4. Gewinne der finanziellen Globalisierung Das Konzept des externen Reichtums und wie man es berechnet. Die langfristige Budgetbeschränkung und ihre Anwendung für Industrie- und Schwellenländer. Konsumglättung, effiziente Investition, finanzielle Offenheit und Risikostreuung. 5. Fixe und flexible Wechselkurssysteme Feste Wechselkurse, Crawling Peg und flexible Wechselkurse: Vor- und Nachteile. Wirtschaftliche Ähnlichkeit und Kosten asymmetrischer Schocks. Kooperative und nicht kooperative Anpassungen der Zinssätze. 6. Währungsunionen Das Mundell-Fleming-Modell, Geld- und Fiskalpolitik. Die Theorie optimaler Währungsräume. Die Anwendung dieser Theorie auf die Eurozone und Zusammenhang mit der Eurokrise.	2 SWS
Lehrveranstaltung: Internationale Finanzmärkte (Übung) *Inhalte*:	2 SWS

In den Übungen werden die Inhalte der Vorlesung anhand von Aufgaben wiederholt und vertieft.	
Prüfung: Klausur (90 Minuten)	6 C

Prüfungsanforderungen: • Nachweis fundierter Kenntnisse der Begriffe im Bereich der internationalen Finanzen durch intuitive und analytische Beantwortung von Fragen, • Nachweis der Fähigkeit zur mathematischen Herleitung der gewinnoptimierenden Entscheidung von hypothetischen Investoren oder Zentralbanken, • Nachweis der Fähigkeit zur grafischen und mathematischen Analyse der finanziellen Globalisierung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-OPH.0008 Makroökonomik I, B.WIWI-VWL.0005: Grundlagen der internationalen Wirtschaftsbeziehungen
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Tino Berger
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 6
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.WIWI-WIN.0001: Management der Informationssysteme** *English title: Management of Business Information Systems*	6 C 3 SWS
Lernziele/Kompetenzen: Nach erfolgreicher Teilnahme sind die Studierenden in der Lage: • die Phasen einer Anwendungssystementwicklung zu beschreiben sowie dortige Instrumente erläutern und anwenden zu können, • Vorgehensweisen, Ansätze und Werkzeuge zur Entwicklung von Anwendungssystemen zu beschreiben, gegenüberzustellen und vor dem Hintergrund gegebener Problemstellungen zu bewerten, • Elemente von Modellierungstechniken und Gestaltungsmöglichkeiten von Anwendungssystemen zu beschreiben und zu erläutern, • ausgewählte Methoden zur Modellierung von Anwendungssystemen selbstständig anwenden zu können, • Prinzipien der Anwendungssystementwicklung auf gegebene Problemstellungen transferieren zu können, • Modellierungsaufgaben im Themenfeld der Vorlesung eigenständig zu bearbeiten, zu reflektieren und konstruktiv zu bewerten.	**Arbeitsaufwand:** Präsenzzeit: 38 Stunden Selbststudium: 142 Stunden
Lehrveranstaltung: Management der Informationssysteme (Vorlesung) *Inhalte*: Die Veranstaltung Management der Informationssysteme (MIS) beschäftigt sich mit der produktorientierten Gestaltung der betrieblichen Informationsverarbeitung. Unter Produkt wird hier das Anwendungssystem bzw. eine ganze Landschaft aus Anwendungssystemen verstanden, die es zu gestalten, zu modellieren und zu organisieren gilt. Der Fokus der Veranstaltung liegt auf der Vermittlung von Vorgehensweisen sowie Methoden und konkreten Instrumenten, welche es erlauben, Anwendungssysteme logisch-konzeptionell zu gestalten. - Grundlagen der Systementwicklung • Herausforderungen bei der Einführung einer neuen Software • Vorgehensweisen zur Systementwicklung (z. B. Prototyping) • Grunds. Ansätze der Systementwicklung (z. B. Geschäftsprozessorientierter Ansatz) - Planung- und Definitionsphase • Methoden zur Systemplanung (z. B. Portfolio-Analyse) • Methoden zur System-Wirtschaftlichkeitsberechnung (z. B. Kapitalwertmethode) • Lastenhefte • Pflichtenhefte - Entwurfsphase • Geschäftsprozessmodell (z. B. Ereignisgesteuerte Prozessketten) • Funktionsmodell (z. B. Anwendungsfall-Diagramm) • Datenmodell (z. B. Entity-Relationship-Modell)	2 SWS

• Objektmodell (z. B. Klassendiagramm) • Gestaltung der Benutzungsoberfläche (Prinzipien / Standards) • Datenbankmodelle - Implementierungsphase • Prinzipien des Programmierens • Arten von Programmiersprachen • Übersetzungsprogramme • Werkzeuge (z. B. Anwendungsserver) - Abnahme- und Einführungsphase • Qualitätssicherung (z. B. Systemtests) • Prinzipien der Systemeinführung - Wartungs- und Pflegephase • Wartungsaufgaben • Portfolio-Analyse	
Lehrveranstaltung: Management der Informationssysteme (Tutorium) *Inhalte*: • Vorstellung des grundlegenden Funktionsumfangs ausgewählter Modellierungssoftware, • Einführung in die Grundlagen des Modellierens, • Tutorielle Begleitung bei der Bearbeitung von Fallstudien.	1 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Erfolgreiche Bearbeitung von drei Modellierungsfallstudien und Bewertung von Lösungen im Rahmen eines kollegialen Peer-Review-Verfahrens.	6 C

Prüfungsanforderungen: Die Studierenden weisen in der Modulprüfung nach, dass sie: • die in der Vorlesung vermittelten Aspekte der Anwendungssystementwicklung erläutern und beurteilen können, • Projekte zur Anwendungssystementwicklung in die vermittelten Phasen einordnen können, • Vorgehensweisen, Ansätze und Werkzeuge zur Entwicklung von Anwendungssystemen auf praktische Problemstellungen transferieren können, • komplexe Aufgabenstellungen mit Hilfe der vermittelten Inhalte analysieren und Lösungsansätze selbstständig aufzeigen können, • Vermittelte Methoden zur Modellierung von Anwendungssystemen notationskonform anwenden können und • in der Vorlesung vermittelten Ansätze auf vergleichbare Problemstellungen im Umfeld betrieblicher Anwendungssysteme übertragen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-OPH.0003 Digitalisierung von Unternehmen und Verwaltung

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Matthias Schumann
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Im Wintersemester werden die Vorlesungsinhalte mittels Videos vermittelt.

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.WIWI-WIN.0002: Management der Informationswirtschaft
English title: Fundamentals of Information Management</td><td>6 C
6 SWS</td></tr>
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<tr><td>Lernziele/Kompetenzen:
Die Studierenden:
kennen und verstehen strategische, operative und technische Aspekte des Informationsmanagements im Unternehmen,
kennen und verstehen verschiedene theoretische Modelle und Forschungsfelder des Informationsmanagements,
kennen und verstehen die Aufgaben des strategischen IT-Managements, der IT-Governance, des IT Controllings und des Sicherheits- sowie IT-Risk-Managements,
kennen und verstehen die Konzepte und Best-Practices im Informationsmanagement von Gastreferenten in deren Unternehmen,
analysieren und evaluieren Journal- und Konferenzbeiträge hinsichtlich wissenschaftlicher Fragestellungen,
analysieren und evaluieren praxisorientierte Fallstudien hinsichtlich des Beitrags des Informationsmanagements für den wirtschaftlichen Erfolg eines Unternehmens.</td><td>Arbeitsaufwand:
Präsenzzeit:
84 Stunden
Selbststudium:
96 Stunden</td></tr>
</table>

<table>
<tr><td>Lehrveranstaltung: Management der Informationswirtschaft (Vorlesung)
Inhalte:
Modelle des Informationsmanagements
Grundlagen der Informationswirtschaft
Strategisches IT-Management & IT-Governance
IT-Organisation
Sicherheitsmanagement & IT- Risk Management
Außenwirksame IS & e-Commerce
IT-Performance Management
Umsetzung & Betrieb, Green IT
Projektmanagement
Highlights / Q&A</td><td>2 SWS</td></tr>
<tr><td>Lehrveranstaltung: Methodische Übung Management der Informationswirtschaft
(Übung)</td><td>2 SWS</td></tr>
<tr><td>Lehrveranstaltung: Inhaltliche Übung Management der Informationswirtschaft
(Übung)</td><td>2 SWS</td></tr>
<tr><td>Prüfung: Klausur (90 Minuten)
Prüfungsanforderungen:
Nachweis von Kenntnissen über Grundlagen der Informationswirtschaft.</td><td>6 C</td></tr>
</table>

<table>
<tr><td>Zugangsvoraussetzungen:
keine</td><td>Empfohlene Vorkenntnisse:
Orientierungsphase</td></tr>
<tr><td>Sprache:</td><td>Modulverantwortliche[r]:</td></tr>
</table>

Deutsch	Prof. Dr. Lutz Maria Kolbe
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

Angebotshäufigkeit

Das Modul wird in jedem Semester angeboten**.** Im Wintersemester wird die Vorlesung und Übung regulär gehalten. Im Sommersemester findet nur die Übung statt. Die Vorlesung ist im Selbststudium zu erarbeiten. Grundlage dafür ist die aufgezeichnete Vorlesung des jeweils vorhergehenden Wintersemesters.

Georg-August-Universität Göttingen **Modul M.Che.1311: Schwingungsspektroskopie und zwischenmolekulare Dynamik** *English title: Vibrational Spectroscopy and Intermolecular Dynamics*	6 C 5 SWS

Lernziele/Kompetenzen: • Die Absolvent*innen dieses Moduls haben vertiefte theoretische Kenntnisse zur Schwingungsspektroskopie und zwischenmolekularen Dynamik, sowie deren Ausstrahlung auf andere Gebiete der Naturwissenschaften erworben und sind in der Lage, quantitative Fragestellungen dazu zu erfassen und zu lösen. • Insbesondere verstehen sie harmonische und anharmonische Kopplungen, Intensitätseffekte, fortgeschrittene Symmetrieaspekte und experimentelle Techniken der Schwingungsspektroskopie. • Sie können zwischenmolekulare Wechselwirkungen beschreiben, die sich daraus ergebenden Potentialhyperflächen, Aggregatstrukturen und dynamischen Phänomene analysieren und experimentelle Methoden der Spektroskopie von Molekülaggregaten vergleichen.	**Arbeitsaufwand:** Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden

Lehrveranstaltung: Schwingungsspektroskopie und zwischenmolekulare Dynamik (Vorlesung)	3 SWS
Prüfung: Klausur (180 Minuten)	6 C

Lehrveranstaltung: Schwingungsspektroskopie und zwischenmolekulare Dynamik (Übung)	2 SWS

Prüfungsanforderungen: Erfassung und quantitative Lösung von exemplarischen Fragestellungen aus dem Forschungsgebiet mit begrenzten Hilfsmitteln in vorgegebener Zeit, mindestens 50% der Sollpunktzahl.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Martin Suhm
Angebotshäufigkeit: unregelmäßig (jedes zweite oder dritte Semester)	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 1 - 2
Maximale Studierendenzahl: 64	

Bemerkungen: Die aktive Teilnahme an den angebotenen Übungsstunden wird dringend empfohlen.

Georg-August-Universität Göttingen **Modul M.Che.1313: Elektronische Spektroskopie und Reaktionsdynamik** *English title: Electronic Spectroscopy and Reaction Dynamics*	6 C 5 SWS
Lernziele/Kompetenzen: Die Absolvent*innen dieses Moduls haben vertiefte theoretische Kenntnisse zur elektronischen Spektroskopie und Reaktionsdynamik sowie deren Ausstrahlung auf andere Gebiete der Naturwissenschaften erworben und sind in der Lage, quantitative Fragestellungen dazu zu erfassen und zu lösen.	**Arbeitsaufwand:** Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden
Lehrveranstaltung: Elektronische Spektroskopie und Reaktionsdynamik (Vorlesung)	3 SWS
Prüfung: Klausur (180 Minuten)	6 C
Lehrveranstaltung: Elektronische Spektroskopie und Reaktionsdynamik (Übung)	2 SWS
Prüfungsanforderungen: Erfassung und quantitative Lösung von exemplarischen Fragestellungen aus dem Forschungsgebiet mit begrenzten Hilfsmitteln in vorgegebener Zeit, mindestens 50% der Sollpunktzahl.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Dr. Oliver Bünermann
Angebotshäufigkeit: unregelmäßig (jedes zweite oder dritte Semester)	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 1 - 2
Maximale Studierendenzahl: 64	

Bemerkungen: Die aktive Teilnahme an den angebotenen Übungsstunden wird dringend empfohlen.

Georg-August-Universität Göttingen **Modul M.Che.1314: Biophysikalische Chemie** *English title: Biophysical Chemistry*	6 C 5 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Abschluss des Moduls ... • sollen die Studierenden in der Lage sein, die wesentlichen physikochemischen Zusammenhänge biologischer Materie zu verstehen • die generellen Triebkräfte biologischer Reaktionen kennen • Spektroskopische Methoden zur Strukturbestimmung biologischer Makromoleküle verstehen und anwenden können • die Grundzüge moderner optischer Mikroskopie sowie der Sondenmikroskopie verstanden haben • die Mechanik und Dynamik biologischer Systeme ausgehend vom Einzelmolekül bis zur einzelnen Zelle erörtern können	**Arbeitsaufwand:** Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden

Lehrveranstaltung: Biophysikalische Chemie (Vorlesung)	3 SWS
Prüfung: Klausur (180 Minuten)	6 C

Lehrveranstaltung: Biophysikalische Chemie (Übung)	2 SWS

Prüfungsanforderungen: • Übertragung genereller physikochemischer Prinzipien, wie zum Beispiel der Reaktionsdynamik, (statistischen) Thermodynamik und Quantentheorie auf die Beschreibung biologischer Phänomene • Beschreibung biologisch relevanter Wechselwirkungskräfte, stochastischer Prozesse wie Diffusion, physikalischer Biopolymer-Modelle, der Eigenschaften von Biomembranen und der Visikoelastizität von weicher Materie. • Kenntnisse der wesentlichen Methoden, wie z.B. UV-Vis, Circulardichroismus, Rasterkraftmikroskopie, optische Fallen, Fluoreszenz, und optische Mikroskopie.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Janshoff
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 1 - 2
Maximale Studierendenzahl: 64	

Georg-August-Universität Göttingen Module M.Che.1315: Chemical Dynamics at Surfaces	6 C 5 WLH
Learning outcome, core skills: The students of this module will achieve a deeper theoretical knowledge of chemical dynamics on surfaces as well as their influence on other fields in natural science, in order that they will be able to approach and solve problems regarding the quantitative questions in this field.	**Workload:** Attendance time: 70 h Self-study time: 110 h
Course: Chemical Dynamics at Surfaces (Lecture)	3 WLH
Examination: Written examination (180 minutes)	6 C
Course: Chemical Dynamics at Surfaces (Exercise)	2 WLH
Examination requirements: By Understanding and solving exemplary questions regarding this research field with the help of limited reference material in predetermined time will count as minimum 50 % of the required score	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Alec Wodtke
Course frequency: irregular (every second or third semester)	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 2
Maximum number of students: 64	

Additional notes and regulations:
Active participation in provided tutorial is recommanded.

Georg-August-Universität Göttingen **Modul M.Inf.1112: Effiziente Algorithmen** *English title: Efficient Algorithms*	5 C 3 SWS

Lernziele/Kompetenzen: Erwerb fortgeschrittener Kenntnisse und Fähigkeiten zur Entwicklung und Analyse effizienter Algorithmen und zur Untersuchung der Komplexität von Problemen in unterschiedlichen Anwendungsbereichen.	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 108 Stunden

Lehrveranstaltung: Vorlesung/Übung *Inhalte*: Zum Beispiel: Randomisierte und Approximationsalgorithmen, Graphalgorithmen, Onlinealgorithmen, Netzwerkalgorithmen, Neurocomputing, Pattern-Matching-Algorithmen.	3 SWS
Prüfung: Klausur (90 Min.) oder mündliche Prüfung (ca. 25 Min.). **Prüfungsanforderungen:** Fähigkeit zum Entwurf von effizienten Algorithmen für gegebene Probleme. Beurteilungskompetenz von deren inherenter Komplexität in den Bereichen der Kerninformatik und ggf. ihren Anwendungen.	5 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Carsten Damm (Prof. Dr. Florentin Andreas Wörgötter)
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Inf.1141: Semistrukturierte Daten und XML** *English title: Semistructured Data and XML*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden kennen die Konzepte semistrukturierter Datenmodelle und die Parallelen sowie Unterschiede zum "klassischen" strukturierten, relationalen Datenmodell. Sie können damit für eine Anwendung abschätzen, welche Technologien gegebenenfalls zu wählen und zu kombinieren sind. Die Studierenden verfügen über praktische Grundkenntnisse in den üblichen Sprachen dieses Bereiches. Sie haben einen Überblick über die historische Entwicklung von Modellen und Sprachen im Datenbankbereich und können daran wissenschaftliche Fragestellungen und Vorgehensweisen nachvollziehen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Semistrukturierte Daten und XML (Vorlesung, Übung)	
Prüfung: Klausur (90 Min.) oder mündliche Prüfung (ca. 25 Min.) **Prüfungsanforderungen:** Konzepte semistrukturierter Datenmodelle und die Parallelen sowie Unterschiede zum "klassischen" strukturierten, relationalen Datenmodell; Fähigkeit zur Beurteilung, welche Technologien in einer konkreten Anwendung zu wählen und zu kombinieren sind; praktische Grundkenntnisse in den üblichen Sprachen dieses Bereiches; Überblick über die historische Entwicklung von Modellen und Sprachen im Datenbankbereich; Fähigkeit zum Nachvollziehen wissenschaftlicher Fragestellungen und Vorgehensweisen.	6 C

Zugangsvoraussetzungen: Datenbanken	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Wolfgang May
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen Module M.Inf.1171: Cloud and Service Computing	5 C 3 WLH
Learning outcome, core skills: Successfully completing the module, students understand • hybrid clouds, consisting of private and public clouds • basic web technologies (transfer protocols, markup languages, markup processing, RESTful and SOAP web services) • virtualization technologies (server, storage, and network virtualization) • data services (sharing, management, and analysis) • continuous integration/continuous delivery • container and orchestration in clouds (e.g. Kubernetes, OpenStack Heat) • monitoring of cloud infrastructures • interoperability in clouds (e.g. Helm) • portability and security • microservices • cloud computing workloads On completion of this module students will have a good understanding of the fundamental and up-to-date concepts used in the context cloud computing. This basic knowledge can be leveraged by students to design, implement, and manage service-oriented cloud infrastructures by themselves.	**Workload:** Attendance time: 42 h Self-study time: 108 h
Course: Cloud and Service Computing (Lecture, Exercise) *Contents*: Cloud Computing is a method of providing shared computing resources, such as applications, computing, storage, networking, development, and deployment platforms. In cloud computing these resources can be delivered as service to the user. Such Service-oriented infrastructures are the backbone of modern IT systems. They pool resources, enable collaboration between people, and provide complex services to end-users. Everybody who uses today's web applications implicitly relies on sophisticated service-oriented infrastructures. The same is true for users of mobile devices such as tablet computers and smart phones, which provide most of their benefits leveraging services. The key challenges of cloud computing infrastructures are related to scaling services. More specifically large cloud-computing infrastructures require scalability of IT management, programming models, and power consumption. The challenges to scale services lie in the inherent complexity of hardware, software, and the large amount of user requests, which large-scale services are expected to handle. This module teaches methods that address and solve those challenges in practice. Key aspects of the module are the management of IT infrastructures, the management of service landscapes, and programming models for distributed applications. The module covers the virtualization of computing, storage, and network resources as the fundament for scaling. IT management is covered by the discussion of deployment	3 WLH

models, service level agreements. Programming models are covered by discussing RESTful and SOAP web-services. Both, lectures and exercises, keep a close connection to the practical application of the discussed topics. The practical value of service-oriented infrastructures is highlighted in the context of enterprises as well as in the context of science. The methods taught in this module benefit from the lecturers' experiences at GWDG and thus provide exclusive insights into the topic. After successfully attending these modules students will understand the most important aspects to design, implement, and manage internet-scale cloud computing infrastructures.	
Examination: Written exam (90 min) or oral exam (approx. 30 min) **Examination requirements:** • Hybrid and Multi cloud infrastructures • RESTful and SOAP web services • Compute, storage, and network virtualisation • Infrastructure-as-a-service, platform-as-a-service, software-as-a-service • Characteristics of Cloud computing (NIST) • Service life cycle • Service level agreements • Cloud computing workloads (e.g. batch, SaaS, big data, back-end)	5 C

Admission requirements: none	**Recommended previous knowledge:** • Basic programming skills • Basic knowledge of Linux operating systems
Language: English	**Person responsible for module:** Prof. Dr. Ramin Yahyapour
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

Georg-August-Universität Göttingen Module M.Inf.1172: Using Research Infrastructures	5 C 3 WLH
Learning outcome, core skills: Successfully completing the module, students • understand what methods and services are available in state-of-the-art research infrastructures and direction of future development • understand the infrastructures for eScience and eResearch • know basics of data management and data analysis • know the fundamental of technologies like cloud computing and grids • understand the real-world problems from different domains (e.g., high energy physics, humanities, medical science, etc.) which are tackled by research infrastructures • understand certain aspects, methods and tools of these infrastructures for different use cases from different domains • will be motivated to take part in other related modules (e.g., Specialization in Distributed Systems, Parallel Computing, etc.)	**Workload:** Attendance time: 42 h Self-study time: 108 h
Course: Using Research Infrastructures - Examples from Humanities and Sciences (Lecture, Exercise) *Contents*: Successfully completing the lecture, students • understand the role and importance of the research infrastructure and their general building blocks • know the basics of grid computing • know the basics of cloud computing • learn basics on system virtualization • learn fundamental ideas of data management and analysis • understand the real-world problems from different domains (e.g., high energy physics, humanities, medical science/life science, etc.) which are tackled by research infrastructures • understand certain aspects, methods and tools of these infrastructures for different use cases from different domains • will be motivated to take part in other related modules (e.g., Specialization in Distributed Systems, Parallel Computing, etc.) • get familiar with real-world challenges through talks from experts who will present their current research activities and the role of research infrastructures on their research	3 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Grid computing; cloud computing; system virtualization; data management; data analysis; application of eResearch infrastructure in high energy physics; eResearch in medicine and life science; eResearch in humanities	5 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Ramin Yahyapour
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Georg-August-Universität Göttingen Module M.Inf.1185: Sensor Data Fusion	5 C 4 WLH

Learning outcome, core skills: This module is concerned with fundamental principles and algorithms for the processing and fusion of noisy (sensor) data. Applications in the context of navigation, object tracking, sensor networks, robotics, Internet-of-Things, and data science are discussed. After successful completion of the module, students are able to • define the notion of data fusion and distinguish different data fusion levels • formalize data fusion problems as state estimation problems • develop distributed and decentralized data fusion architectures • describe the basic concepts of linear estimation theory • explain the fundamental formulas for the fusion of noisy data • deal with unknown correlations in data fusion • understand the Bayesian approach to data fusion and estimation • formulate dynamic models for time-varying phenomena • describe the concept of a recursive Bayesian state estimator • explain and apply the Kalman filter for state estimation in dynamic systems • explain and apply basic nonlinear estimation techniques such as the Extended Kalman filter (EKF) and Unscented Kalman filter (UKF) • assess the properties, advantages, and disadvantages of the discussed (nonlinear) estimators • explain different approaches to deal with uncertainty such as probability theory, fuzzy theory, and Dempster–Shafer theory • identify data fusion applications and assess the benefits of data fusion	**Workload:** Attendance time: 56 h Self-study time: 94 h

Course: Sensor Data Fusion (Lecture, Exercise)	4 WLH
Examination: Written exam (90 min.) or oral exam (approx. 20 min.) **Examination requirements:** Definition of data fusion; data fusion levels; formalization of data fusion problems; distributed and decentralized fusion architectures; linear estimation theory; fundamental fusion formulas; dynamic state estimation; Kalman filter; Extended Kalman filter (EKF); Unscented Kalman filter (UKF), algorithms for dealing with unknown correlations; fuzzy theory; Dempster-Shafer theory	5 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Marcus Baum
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**

Maximum number of students: 50	

Georg-August-Universität Göttingen Module M.Inf.1186: Seminar Hot Topics in Data Fusion and Analytics	5 C 2 WLH
Learning outcome, core skills: After successful completion of the modul students are able to • get acquainted with a specific research topic in the area of data fusion and data analytics • explain the considered problem in the chosen research topic • collect, evaluate, and summarize related work • describe solution approaches for the considered problem • discuss advantages and disadvantages of the proposed approaches • give an outlook to future research directions • prepare and give a presentation about the chosen research topic • write a scientific report about the chosen research topic • follow recent research in data fusion and data analytics	**Workload:** Attendance time: 28 h Self-study time: 122 h
Course: Hot Topics in Data Fusion and Analytics (Seminar)	2 WLH
Examination: Presentation (approx. 45 minutes) and written report (max. 20 pages) **Examination prerequisites:** Attendance in 80% of the seminar presentations **Examination requirements:** Advanced knowledge of a specific research topic in the field of data fusion and data analytics; written scientific report; oral presentation	5 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Marcus Baum
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 15	

Georg-August-Universität Göttingen Module M.Inf.1188: Mobile Robotics	5 C 4 WLH
Learning outcome, core skills: This module is concerned with fundamental principles and algorithms for mobile robot navigation and perception. After completion, the students are able to • model the locomotion of wheeled mobile robots • understand the concept of dead reckoning • describe the most common sensors for mobile robots, e.g., inertial sensors and beam-based sensors • employ probabilistic state estimation methods such as Kalman filters and sequential Monte Carlo methods (particle filters) for robot navigation and perception • describe and distinguish different concepts for localization such as trilateration and triangulation • implement and evaluate basic algorithms for localization • understand the robot mapping problem and explain different map representations such as occupancy grids • describe the problem of Simultaneous Localization and Mapping (SLAM) • implement and evaluate basic algorithms for SLAM such as graph-based approaches and Rao-Blackwellized particle filters • implement and evaluate basic feature extraction methods such as Random Sample Consensus (RANSAC) • design basic planning algorithms for mobile robots using, e.g., a Markov Decision Process (MDP)	**Workload:** Attendance time: 56 h Self-study time: 94 h

Course: Mobile Robotics (Lecture, Exercise)	4 WLH
Examination: Written exam (90 min.) or oral exam (approx. 20 min.) **Examination requirements:** Motion models for wheeled robots; dead reckoning; mobile robot sensors; Kalman filter; particle filter; localization concepts and algorithms; robot mapping; Simultaneous Localization and Mapping (SLAM); feature extraction methods; planning algorithms	5 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Marcus Baum
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: not limited	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.Inf.1216: Datenkompression und Informationstheorie
English title: Data Compression and Information Theory</td><td>6 C
4 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Die Studierenden
kennen den schematischen Aufbau von Kommunikationssystemen und verstehen ihre stochastischen/algorithmischen Beschreibungen
kennen die Grundbegriffe und Sätze der Shannonschen und der algorithmischen Informationstheorie und können sie in konkreten Situationen anwenden
kennen grundlegende verlustfreie Quellencodes (Huffman, Shannon, Lauflängen) und Erweiterungen sowie arithmetische Codes und können ihre Eignung in Anwendungssituationen bewerten
verstehen das Prinzip der Codeadaptionen und seine Implementierung anhand ausgewählter Codes
kennen allgemeine Entwurfsprinzipien für Quellencodes und verstehen ihre Umsetzung in konkreten Implementierungen
kennen die Schritte der verlustbehafteten Datenkompression und können ihre Leistungsparameter analysieren
kennen die Grundzüge der Ratenverzerrungstheorie und können sie in konkreten Situationen anwenden
kennen wichtige Beispiele verlustbehafteter Datenkompression, können sie analysieren und in Anwendungssituationen bewerten</td><td>Arbeitsaufwand:
Präsenzzeit:
56 Stunden
Selbststudium:
124 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Datenkompression und Informationstheorie (Vorlesung, Übung)</td><td>4 SWS</td></tr>
<tr><td>Prüfung: Klausur (90 Min.) oder mündliche Prüfung (ca. 20 Min.)
Prüfungsvorleistungen:
Bearbeitung von 50% aller Übungsblätter, Vorführung mindestens einer Aufgabe während der Übung, kontinuierliche Teilnahme an den Übungen
Prüfungsanforderungen:
In der Prüfung wird die aktive Beherrschung der vermittelten Inhalte und Techniken nachgewiesen, z.B.
Verständnis der Zusammenhänge durch Umschreibung in eigenen Worten nachweisen
Konstruktion von Codes nach Vorgabe stochastischer Parameter
Schätzung stochastischer Parameter von Quellen und Kanälen
begründete Auswahl von Codierungsverfahren in hypothetischer Anwendungssituation
Codeparameter, Kanalkapazität etc. berechnen
(teilweise) programmtechnische Umsetzung von Quellen (de-)codierern
modulare Beschreibung konkreter Kommunikationssysteme darlegen
Leistungsparameter konkreter Quellencodierverfahren analysieren</td><td>6 C</td></tr>
</table>

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**

keine	Beherrschung einer Programmiersprache
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Carsten Damm
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen Module M.Inf.1231: Specialisation in Distributed Systems	6 C 4 WLH
Learning outcome, core skills: Successfully completing the module, students • have in-depth knowledge about one specific topical area of distributed systems • understand the challenges of designing this specific part of a distributed system and integrating it into a larger infrastructure • understand the tasks to operate this specific part of a distributed system within a modern data centre • can apply their knowledge to evaluate application scenarios and make decisions regarding the applicability of certain technical solutions Examples for specific topics are distributed architectures or distributed data and information management.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Distributed Storage and Information Management (Lecture, Exercise) *Contents*: Successfully completing the module, students • understand how data and information can be stored and managed • know the generic components of a modern data centre • understand how to protect data using RAID and what RAID level to apply to what problem • know about “intelligent” storage systems, including concepts like caching • understand various storage networking technologies like Fibre Channel, iSCSI, and FCoE • know about network-attached, object and unified storage • basically understand how to achieve business continuity of storage systems • understand the different backup and archiving technologies • understand data replication • have a basic understanding of storage virtualization • know how to manage and how to secure storage infrastructures Remark With this lecture, we provide a preparation for the exam for the EMC Information Storage and Management Certificate. The Institute of Computer Science of the University of Göttingen is a Proven Professional of the EMC Academic Alliance. References S. Gnanasundaram, A. Shrivastava (eds.), Information Storage and Management, John Wiley & Sons, 2012. ISBN:978-1-118-09483-9	4 WLH
Examination: Written exam (90 min.) or oral exam (ca. 20 min.) **Examination prerequisites:** Solving and presenting at least one exercise (written solution and presentation), as well as active participation during the exercises.	6 C

Examination requirements: Information Storage; Data Centre Environment and Components; RAID; Caching; Storage Provisioning; Fibre Channel; IP SAN; FCoE; Network-Attached Storage; Object-Based and Unified Storage; Backup and Archiving; Replication; Storage Cloud; Security in Storage Infrastructures; Management of Storage Infrastructures	

Admission requirements: none	**Recommended previous knowledge:** • Computer architecture • Basic network protocols • Virtualisation techniques
Language: English	**Person responsible for module:** Prof. Dr. Ramin Yahyapour (Dr. Philipp Wieder)
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Georg-August-Universität Göttingen Module M.Inf.1232: Parallel Computing	6 C 4 WLH

Learning outcome, core skills: Successfully completing the module, students are able to: • define and describe the benefit of parallel computing • specify the classification of parallel computers (Flyn classification) • analytically evaluate the performance of parallel computing approaches (scaling/ performance models) • know the parallel hardware and performance improvement approaches (cache coherence, pipeline, etc.) • know the interconnects and networks and their role in parallel computing • understand and develop sample parallel programs using different paradigms and development environments (e.g., shared memory and distributed models) • expose to some applications of Parallel Computing through hands-on exercises	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Parallel Computing (Lecture, Exercise) *Contents*: Successfully completing the lecture, students are able to: • define and describe the benefit of parallel computing and identify the role of software and hardware in parallel computing • specify the Flynn classification of parallel computers (SISD, SIMD, MIMD) • analytically evaluate the performance of parallel computing approaches (Scaling/ Performance models) • understand the different architecture of parallel hardware and performance improvement approaches (e.g., caching and cache coherence issues, pipeline, etc.) • define Interconnects and networks for parallel computing • architecture of parallel computing (MPP, Vector, Shared memory, GPU, Many-Core, Clusters, Grid, Cloud) • design and develop parallel software using a systematic approach • parallel computing algorithms and development environments (i.e. shared memory and distributed memory parallel programming) • write parallel algorithms/programs using different paradigms and environments (e.g., POSIX Multi-threaded programming, OpenMP, MPI, OpenCL/CUDA, MapReduce, etc.) • get exposed to some applications of Parallel Computing through exercises References • An Introduction to Parallel Programming, Peter S. Pacheco, Morgan Kaufmann (MK), 2011, ISBN: 978-0-12-374260-5. • Designing and Building Parallel Programs, Ian Foster, Addison-Waesley, 1995, ISBN 0-201-57594-9 (Available online).	4 WLH

• Advanced Computer Architecture: Parallelism, Scalability, Programmability, Kai Hwang, Int. Edition, McGraw Hill, 1993, ISBN: 0-07-113342-9. • In addition to the mentioned text book, tutorial and survey papers will be distributed in some lectures as extra reading material.	
Examination: Klausur (90 Min.) oder mündliche Prüfung (ca. 20 Min.) **Examination requirements:** Parallel programming; Shared Memory Parallelism; Distributed Memory Parallelism, Single Instruction Multiple Data (SIMD); Multiple Instruction Multiple Data (MIMD); Hypercube; Parallel interconnects and networks; Pipelining; Cache Coherence; Parallel Architectures; Parallel Algorithms; OpenMP; MPI; Multi-Threading (pthreads); Heterogeneous Parallelism (GPGPU, OpenCL/CUDA)	6 C

Admission requirements: • Data structures and algorithms • Programming in C/C++	**Recommended previous knowledge:** • Computer architecture • Basic knowledge of computer networks and topologies
Language: English	**Person responsible for module:** Prof. Dr. Ramin Yahyapour
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module M.Inf.1244: Seminar on optimal transport**	5 C 2 WLH

Learning outcome, core skills: By using original references students will familiarize themselves with advanced aspects of optimal transport theory or its applications in modern data analysis and machine learning and present their findings to the other participants. • read and understand original research papers or graduate-level textbooks • collect background material on a given topic and its context • order and prioritize this material for a presentation • prepare a structured presentation with a corresponding handout • give an accessible presentation • answer questions from the audience that may go slightly beyond the presentation material • leading and participating in a scientific discussion	**Workload:** Attendance time: 28 h Self-study time: 122 h

Course: Seminar on optimal transport (Seminar)	2 WLH
Examination: Presentation (approx. 45 min.), follow-up discussion, and handout (max. 5 pages) **Examination requirements:** Advanced knowledge on a specific topic in optimal transport research; structured presentation; handout	5 C

Admission requirements: none	**Recommended previous knowledge:** Lecture “Computational optimal transport” or some course on optimization are strongly recommended.
Language: English	**Person responsible for module:** Prof. Dr. Bernhard Schmitzer
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 15	

Georg-August-Universität Göttingen **Modul M.Inf.1802: Praktikum XML** *English title: Practical Course on XML*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden verfügen über vertiefte Kenntnisse und Erfahrungen mit Konzepten und Sprachen aus dem Bereich XML. Sie wissen, welche Sprachen und Werkzeuge ggf. bei Problemstellungen anwendbar sind und können Projekte in diesem Bereich umsetzen. Sie sind mit der Grundidee der W3C-Standards vertraut und können sich selber benötigte Informationen im Web zusammensuchen. Vermittlung von praktischen Fähigkeiten aus dem Bereich XML, XPath, XQuery, XSLT, Web Services und weiteren Sprachen und Werkzeugen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Praktikum XML (Praktikum)	
Prüfung: Praktische Prüfung (ca. 4 Übungs- und Programmieraufgaben) und mündliche Prüfung (ca. 20 Min.) **Prüfungsanforderungen:** Vertiefte Kenntnisse und Erfahrungen in Sprachen aus dem Bereich XML. Kenntnisse darüber, welche Sprachen und Werkzeuge ggf. bei Problemstellungen anwendbar sind; Fähigkeit zum Umsetzen von Projekten in diesem Bereich; Kenntnisse der W3C-Standards.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** M.Inf.1141
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Wolfgang May
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul M.Inf.1806: Projektseminar Datenbanken und Informationssysteme** *English title: Seminar and Project Databases*	6 C 2 SWS

Lernziele/Kompetenzen: Die Studierenden können sich in ein Spezialgebiet moderner Datenbank- und Informationssysteme einarbeiten, Quellen und Dokumentationen im Web suchen und in Beziehung zu dem behandelten Gebiet setzen, Werkzeuge evaluieren sowie in einer Diskussion darstellen und bewerten.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

Lehrveranstaltung: Projektseminar Datenbanken und Informationssysteme	
Prüfung: Vortrag (ca. 60 Min.) mit schriftlicher Ausarbeitung (max. 25 Seiten) **Prüfungsanforderungen:** Nachweis über den Erwerb vertiefter Kenntnisse und Fähigkeiten in einem Spezialgebiet moderner Datenbank- und Informationssysteme. Insbesondere zur Darstellung und Bewertung von Quellen, Dokumentationen und Werkzeugen. Der Vortrag umfasst eine Präsentation einer Fallstudie.	6 C

Zugangsvoraussetzungen: Datenbanken	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Wolfgang May
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 16	

Georg-August-Universität Göttingen Module M.Inf.1808: Practical Course on Parallel Computing	6 C 4 WLH
Learning outcome, core skills: Successfully completing the module, students are able to: • practically work with a cluster of computers (e.g., using a batch system) • practically utilize grid computing infrastructures and manage their jobs (e.g., Globus toolkit) • apply distributed memory architectures for parallelism through practical problem solving (MPI programming) • utilize shared memory architectures for parallelism (e.g., OpenMP and pthreads) • utilize heterogenous parallelism (e.g., OpenCL, CUDA and general GPU programming concepts) • utilize their previous knowledge in data structures and algorithms to solve problems using their devised (or enhanced) parallel algorithms	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Practical Course on Parallel Computing (Practical course) *Contents*: As a practical course, the focus will be on the hands-on session and problem solving. Students will get a brief introduction to the topic and then will use the laboratory equipment to solve assignments of each section of the course.	4 WLH
Examination: Oral examination (approx. 20 minutes), not graded **Examination requirements:** • understand how to manage computing jobs using a cluster of computers or using grid computing facilities • understand the configuration of a PBS cluster through practical assignments • practically use LRM clusters and POVRay examples • understand cluster computing related topics (error handling, performance management, security) in more depth and using hands-on experience and practically using Globus toolkit • design and implement solutions for parallel programs using distributed memory architectures (using MPI) • design and implement solutions for parallel programs using shared memory parallelism (using OpenMP, pthreads) • practically work with MapReduce programming framework and problem solving using MapReduce • practically work with heterogenous parallelism environment (GPGPU, OpenCL, CUDA, etc.)	6 C

Admission requirements:	**Recommended previous knowledge:**
• Data structures and algorithms • Programming in C(/C++)	• Parallel Computing • Computer architecture • Basic knowledge of computer networks • Basic know-how of computing clusters

Language: English	**Person responsible for module:** Prof. Dr. Ramin Yahyapour
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Inf.2102: Advanced Statistical Learning for Data Science**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Students will • learn concepts of advanced statistical methods and their scope of applications. These methods comprise the EM algorithm, Markov models, Hidden Markov Models, Markov chain Monte Carlo. • gain a solid understanding of ensemble learning algorithms. In particular, we will address additive tree approaches like boosting and Random Forest algorithms, as well as methods for ensemble optimization • learn strategies for model assessment and selection such as nested cross-validation, Monte Carlo validation, or permutation tests. Moreover, this will comprise measures of model quality and robustness. • acquire practical experience in the interpretation of machine learning models and learn required methods for feature selection, importance, stability, and robustness • learn techniques of statistical network inference, their implementation as well as their application to high-dimensional data.	Attendance time: 56 h Self-study time: 124 h

Course: Advanced Statistical Learning for Data Science (Lecture)	2 WLH
Hastie, et al. Elements of Statistical Learning https://web.stanford.edu/~hastie/ElemStatLearn/ Bishop: Pattern Recognition and Machine Learning. https://cs.ugoe.de/prml	
Examination: Written exam (90 min) or oral exam (approx. 20 min) **Examination prerequisites:** M.Inf.2102.Ex: At least 50% of homework exercises solved. **Examination requirements:** Knowledge of advanced statistical methods, ensemble learning, model assessment, and interpretation as well as statistical network inference. Evaluate their advantages and disadvantages and the ability to implement and interpret the results of these techniques.	6 C

Course: Statistical Learning in Data Science Exercise (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of linear algebra and probability Completion of B.Inf.1236 Machine Learning or equivalent
Language: English	**Person responsible for module:** Jun.-Prof. Dr. Anne Christin Hauschild Prof. Dr. Michael Altenbuchinger
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 3

Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.Inf.2201: Probabilistic Machine Learning**	9 C 6 WLH

Learning outcome, core skills: After successful completion of the module, students • know the principles, paradigms, and challenges of probabilistic reasoning • apply basis principles and tools to perform probabilistic reasoning • manipulate distributions and densities of random variables • apply different methods for inference in probabilistic models (direct solving, sampling, variational inference, Laplace approximation) • apply latent variable models for given problems • perform inference in various forms of Gaussian models using closure properties of the Gaussian family • use graphical models to describe and reason about multivariate distributions of random variables • apply and implement learning algorithms in probabilistic models • can choose from a toolbox of basic algorithms for probabilistic inference on given problems • can implement and debug probabilistic algorithms and inference techniques • apply state of the art deep probabilistic models such as variational autoencoders or normalizing flows	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Probabilistic Machine Learning (Lecture)	4 WLH
Examination: Written examination (120 minutes) **Examination requirements:** • Ability to use principles and tools of probabilistic reasoning on given problems • Ability to extend and modify existing algorithms of probabilistic inference • Ability to diagnose problems in algorithms of probabilistic reasoning • Ability to mathematically derive results in probabilistic models • Ability to use graphical models to simplify problems of probabilistic reasoning • Knowledge of common models and algorithms of probabilistic inference (Gaussian, Bayesian logistic regression, autoencoders, normalizing flows, and others). • Knowledge of common sampling algorithms (importance sampling, MCMC)	9 C

Course: Probabilistic Machine Learning – Exercise (Exercise) Bonus % for the final exam can be gathered by successfully solving exercise sheets and defending them to a tutor.	2 WLH

Admission requirements: none	**Recommended previous knowledge:** • Basic knowledge of linear algebra • Basic knowledge of multivariate calculus • Python, in particular numpy • Basic knowledge of probability
Language: English	**Person responsible for module:** Prof. Dr. Fabian Sinz

	Dr. Johannes Söding
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 4
Maximum number of students: 50	

Additional notes and regulations: The course can be taken in parallel to B.Inf.1237 Deep Learning.

Georg-August-Universität Göttingen Module M.Inf.2241: Current Topics in Machine Learning	5 C 2 WLH
Learning outcome, core skills: After successful completion of the module, students • have gained a deeper knowledge in specific topics within the field of machine learning • have improved their oral presentation skills • know how to methodically read and analyse scientific research papers • know how to write an analysis of a specific research field based on their analysis of state-of-the-art research • have improved their ability to work independently in a pre-defined context	**Workload:** Attendance time: 28 h Self-study time: 122 h
Course: Current Topics in Machine Learning (Seminar)	2 WLH
Examination: Oral presentation (approx. 30 min.) and term paper (max. 5000 words) **Examination requirements:** Knowledge in a specific field of machine learning; ability to present the acquired knowledge in a both orally and in a written report.	5 C

Admission requirements: none	**Recommended previous knowledge:** B.Inf.1236 Machine Learning B.Inf.1237 Deep Learning (the seminar can accompany lecture in the same term)
Language: English	**Person responsible for module:** Prof. Dr. Alexander Ecker
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 4
Maximum number of students: 15	

Georg-August-Universität Göttingen **Module M.Mat.0731: Advanced practical course in scientific computing**	10 C 4 WLH
Learning outcome, core skills: **Learning outcome:** After having successfully completed the module, students are familiar with the analysis of problems in the area "Scientific computing" arising in practice. They • develop large programming projects doing individual or group work; • analyse complex data sets and process them; • use special numerical libraries; • are experienced with advanced methods for the numerical solution of applied problems; • are familiar with basic principles of modular and structured programming in the context of scientific computing. **Core skills:** After having successfully completed the module, students possess advanced practical experience in the area "Scientific computing". They will be able to • identify mathematical problems in applied problems and convert them into a mathematical model; • implement numerical algorithms in a programming language or a user system; • structure complex programming tasks such that they can be efficiently done by group work.	**Workload:** Attendance time: 56 h Self-study time: 244 h
Course: Advanced practical course in scientific computing (Internship)	4 WLH
Examination: Term Papermax. 50 pages (not counted appendices), alternatively, presentation (appr. 30 minutes) **Examination prerequisites:** Regular participation in the practical course	10 C
Examination requirements: • analysis and systematisation of applied problems; • knowledge in special methods of optimisation; • good programming skills.	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.2300 Proficiency in object oriented programming
Language: English	**Person responsible for module:** Dean of studies
Course frequency: winter or summer semester, on demand	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

twice	Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations:
Instructor: Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.0741: Advanced practical course in stochastics	10 C 6 WLH

Learning outcome, core skills: **Learning outcome:** After having successfully completed the module, students have deepened and expanded their knowledge of a stochastical simulation and analysis software that they acquired in the module "Practical course in stochastics". They have acquired advanced knowledge in project work in stochastics. They • autonomously implement and interpret more complex stochastical problems using suitable software; • autonomously write more complex programs using suitable software; • master some advanced methods of statistical data analysis and stochastical simulation like e. g. kernel density estimation, the Bootstrap method, the creation of random numbers, the EM algorithm, survival analysis, the maximum-penalized-likelihood estimation and different test methods. **Core skills:** After having successfully completed the module, students will be able to • handle practical problems with the aid of advanced stochastical methods and the suitable stochastical simulation and analysis software and present the obtained results well; • use advanced visualisation methods for statistical data (e. g. of spatial data); • apply different algorithms to the suitable stochastical problem.	**Workload:** Attendance time: 84 h Self-study time: 216 h

Course: Advanced practical course in stochastics (Internship)	6 WLH
Examination: Presentation (appr. 30 minutes) and term paper (max. 50 pages not counted appendices) **Examination prerequisites:** Regular participation in the practical course	10 C

Examination requirements: Special knowledge in stochastics, especially mastery of complex stochastical simulation and analysis software as well as methods for data analysis	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.3140
Language: English	**Person responsible for module:** Dean of studies
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3

Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.0971: Internship**	10 C (incl. key comp.: 10 C)
Learning outcome, core skills: After having successfully completed the module, students have competencies in project-oriented and research-oriented team work as well as in project management. They are familiar with methods, tools and processes of mathematics as well as the organisational and social environment in practice.	**Workload:** Attendance time: 0 h Self-study time: 300 h
Course: Examination colloquium (Colloquium)	
Examination: Presentation (appr. 20 minutes) and written report (max. 10 pages), not graded **Examination prerequisites:** Certificate of the successful completion of the posed duties in accordance with the internship contract	10 C
Examination requirements: Successfully handling of the posed duties according to the internship contract between the student and the enterprise.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dean of studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4; Promotion: 1 - 6
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers of the Unit Mathematics

Georg-August-Universität Göttingen **Module M.Mat.3110: Higher analysis**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** Weighted differently depending on the current course offer, after having successfully passed the module, students are familiar with basic principles of functional analysis respectively the description of linear elliptical differential equations in functional analysis. They • are familiar with the most known examples of function and sequence spaces like spaces of continuous functions, Lp, lp and Sobolev spaces on bounded and unbounded areas; • identify compactness of operators and analyse the solvability of general linear operator equations, especially of boundary value problems for linear elliptical differential equations with variable coefficients with the aid of the Riesz Fredholm theory; • analyse the regularity of solutions of elliptical boundary value problems inside the domain in question and on its boundary; • use basic theorems of linear operators in Banach spaces, especially the Banach-Steinhaus theorem, the Hahn-Banach theorem and the open mapping theorem; • discuss weak convergence concepts and basic characteristics of dual and double-dual spaces; • are familiar with basic concepts of spectral theory and the spectral theorem for bounded, self-adjoint operators. **Core skills:** After having successfully completed the module, students will be able to • formulate and analyse differential equations and other problems in the language of functional analysis; • identify and describe the relevance of characteristics of functional analysis like choice of a suitable function space, completeness, boundedness or compactness; • evaluate the influence of boundary conditions and function spaces for existence, uniqueness and stability of solutions of differential equations.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Functional analysis / Partial differential equations (Lecture)	4 WLH
Examination: Written examination (120 minutes) **Examination prerequisites:** M.Mat.3110.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Functional analysis / Partial differential equations - exercise session (Exercise)	2 WLH

Examination requirements:	

Proof of the advanced knowledge about functional analysis or partial differential equations	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.0021, B.Mat.0022, B.Mat.1100
Language: English	**Person responsible for module:** Dean of studies
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations:

- **Instructor:** Lecturers at the Mathematical Institute or at the Institute of Numerical and Applied Mathematics
- **Written examination:** This module can be completed by taking a lecture course counting towards the modules B.Mat.2100 or B.Mat.2110. Compared to the exams of the modules B.Mat.2100 respectively B.Mat.2110, exams of the module "Higher analysis" have a higher level of difficulty and test advanced knowledge.
- **Exclusions:** The module "Higher analysis" cannot be completed by taking a lecture course that has already been accounted in the Bachelor's studies.

Georg-August-Universität Göttingen Module M.Mat.3130: Operations research	9 C 6 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of the module enables students to learn methods, concepts, theories and applications in the area of the theory of operations research. Depending on the current course offer the following content-related competencies may be pursued. Students • are able to identify problems of operations research in application-oriented problems and formulate them as optimisation problems; • know methods for the modelling of application-oriented problems and are able to apply them; • evaluate the target function included in a model and the side conditions on the basis of their particular important characteristics; • analyse the complexity of the particular resulting optimisation problem; • are able to develop optimisation methods for the solution of a problem of operation research or adapt general methods to special problems; • know methods with which the quality of optimal solutions can be estimated to the upper and lower and apply them to the problem in question; • differentiate between accurate solution methods, approximation methods with quality guarantee and heuristics and evaluate different methods on the basis of the quality of the found solutions and their computing time; • interpret the found solutions for the underlying practical problem and evaluate the model and solution method on this basis. **Core skills:** After having successfully completed the module, students will be able to • discuss basic concepts of the area "Operations research"; • explain basic ideas of proof in the area "Operations research"; • identify typical applications in the area "Operations research".	**Workload:** Attendance time: 84 h Self-study time: 186 h
Course: Lecture course (Lecture)	4 WLH
Examination: Oral examinationappr. 20 minutes, alternatively written examination, 120 minutes **Examination prerequisites:** M.Mat.3130.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C
Course: Exercise session (Exercise)	2 WLH
Examination requirements: Successful proof of the acquired skills and competencies in the area "Operations research"	

Admission requirements:	**Recommended previous knowledge:**

none	B.Mat.2310
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.3140: Mathematical statistics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** After having successfully completed the module "Mathematical statistics", students are familiar with the basic concepts and methods of mathematical statistics. They • understand most important methods of mathematical statistics like estimates, testing, confidence propositions and classification and are able to use them in simple models of mathematical statistics; • evaluate statistical methods mathematically precisely, amongst others via suitable risk and loss concepts; • analyse optimality characteristics of statistical estimate methods via lower and upper bounds; • are familiar with basic statistical distribution models; • are familiar with references of mathematical statistics to other mathematical areas. **Core skills:** After having successfully completed the module, students have acquired basic competencies in mathematical statistics. They will be able to • apply statistical ways of thinking as well as basic mathematical methods of statistics; • formulate statistical models mathematical precisely; • analyse practical statistical problems mathematically precisely with the learned methods.	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Written examination120 minutes, alternatively, oral examination, appr. 20 minutes **Examination prerequisites:** M.Mat.3140.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Successful proof of the acquired skills and competencies in the area "Mathematical statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.1400
Language: English	**Person responsible for module:** Dean of studies
Course frequency:	**Duration:**

not specified	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4511: Specialisation in analytic number theory	9 C 6 WLH

Learning outcome, core skills:	Workload:
Learning outcome: The successful completion of modules of the cycle "Analytic number theory" enables students to learn methods, concepts, theories and applications in the area of "Analytic number theory". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • solve arithmetical problems with basic, complex-analytical, and Fourier-analytical methods; • know characteristics of the Riemann zeta function and more general L-functions, and apply them to problems of number theory; • are familiar with results and methods of prime number theory; • acquire knowledge in arithmetical and analytical theory of automorphic forms, and its application in number theory; • know basic sieving methods and apply them to the problems of number theory; • know techniques used to estimate the sum of the sum of characters and of exponentials; • analyse the distribution of rational points on suitable algebraic varieties using analytical techniques; • master computation with asymptotic formulas, asymptotic analysis, and asymptotic equipartition in number theory. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Analytic number theory"; • prepare substantial ideas of proof in the area "Analytic number theory".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Analytic number theory"	

Admission requirements:	**Recommended previous knowledge:**

none	B.Mat.3311
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3311 "Advances in analytic number theory"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4512: Specialisation in analysis of partial differential equations**	9 C 6 WLH

<table>
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Learning outcome, core skills:
Learning outcome:
The successful completion of modules of the cycle "Analysis of partial differential equations" enables students to learn methods, concepts, theories and applications in the area "Analysis of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

are familiar with the most important types of partial differential equations and know their solutions;
master the Fourier transform and other techniques of the harmonic analysis to analyse partial differential equations;
are familiar with the theory of generalised functions and the theory of function spaces and use these for solving differential partial equations;
apply the basic principles of functional analysis to the solution of partial different equations;
use different theorems of function theory for solving partial different equations;
master different asymptotic techniques to study characteristics of the solutions of partial different equations;
are paradigmatically familiar with broader application areas of linear theory of partial different equations;
are paradigmatically familiar with broader application areas of non-linear theory of partial different equations;
know the importance of partial different equations in the modelling in natural and engineering sciences;
master some advanced application areas like parts of microlocal analysis or parts of algebraic analysis.

Core skills:
After having successfully completed the module, students will be able to

enhance concepts and methods for special problems and applications in the area "Analysis of partial differential equations";
prepare substantial ideas of proof in the area "Analysis of partial differential equations".

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<td>
Workload:
Attendance time:
84 h
Self-study time:
186 h
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Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Analysis of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3312
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3312 "Advances in analysis of partial differential equations"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4513: Specialisation in differential geometry	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Differential geometry" enables students to learn methods, concepts, theories and applications in the area "Differential geometry". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master the basic concepts of differential geometry; • develop a spatial sense using the examples of curves, surfaces and hypersurfaces; • develop an understanding of the basic concepts of differential geometry like "space" and "manifolds", "symmetry" and "Lie group", "local structures" and "curvature", "global structure" and "invariants" as well as "integrability"; • master (variably weighted and sorted depending on the current courses offered) the theory of transformation groups and symmetries as well as the analysis on manifolds, the theory of manifolds with geometric structures, complex differential geometry, gauge field theory and their applications as well as the elliptical differential equations of geometry and gauge field theory; • develop an understanding for geometrical constructs, spatial patterns and the interaction of algebraic, geometrical, analytical and topological methods; • acquire the skill to apply methods of analysis, algebra and topology for the treatment of geometrical problems; • are able to import geometrical problems to a broader mathematical and physical context. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Differential geometry"; • prepare substantial ideas of proof in the area "Differential geometry".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements:	

Proof of the acquisition of special skills and the mastery of special knowledge in the area "Differential geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3313
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3313 "Advances in variational analysis"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4514: Specialisation in algebraic topology**	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Algebraic topology" students get to know the most important classes of topological spaces as well as algebraic and analytical tools for studying these spaces and the mappings between them. The students use these tools in geometry, mathematical physics, algebra and group theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic topology uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic topology and supplement one another complementarily. The following content-related competencies are pursued. Students • know the basic concepts of set-theoretic topology and continuous mappings; • construct new topologies from given topologies; • know special classes of topological spaces and their special characteristics like CW complexes, simplicial complexes and manifolds; • apply basic concepts of category theory to topological spaces; • use concepts of functors to obtain algebraic invariants of topological spaces and mappings; • know the fundamental group and the covering theory as well as the basic methods for the computation of fundamental groups and mappings between them; • know homology and cohomology, calculate those for important examples and with the aid of these deduce non-existence of mappings as well as fixed-point theorems; • calculate homology and cohomology with the aid of chain complexes; • deduce algebraic characteristics of homology and cohomology with the aid of homological algebra; • become acquainted with connections between analysis and topology; • apply algebraic structures to deduce special global characteristics of the cohomology of a local structure of manifolds. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Algebraic topology"; • prepare substantial ideas of proof in the area "Algebraic topology".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes)	9 C

Examination prerequisites: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Algebraic topology"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3314
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3314 "Advances in algebraic topology"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4515: Specialisation in mathematical methods in physics**	9 C 6 WLH
Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Mathematical methods of physics" students get to know different mathematical methods and techniques that play a role in modern physics. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. The topics of the cycle can be divided into four blocks, a cycle normally contains parts of different blocks, that topically supplement each other, but can also be read within one block. The introducing parts of the cycle form the basis for the advanced specialisation area. The topic blocks are • harmonic analysis, algebraic structures and representation theory, (group) effects; • operator algebra, C* algebra and von-Neumann algebra; • operator theory, perturbation and scattering theory, special PDE, microlocal analysis, distributions; • (semi) Riemannian geometry, symplectic and Poisson geometry, quantization. One of the aims is that a connection to physical problems is visible, at least in the motivation of the covered topics. Preferably, in the advanced part of the cycle, the students should know and be able to carry out practical applications themselves. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Mathematical methods of physics"; • prepare substantial ideas of proof in the area "Mathematical methods of physics".	**Workload:** Attendance time: 84 h Self-study time: 186 h
Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C
Course: Exercise session (Exercise)	2 WLH
Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Mathematical methods in physics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3315
Language:	**Person responsible for module:**

English	Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3315 "Advances in mathematical methods in physics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4521: Specialisation in algebraic geometry	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic geometry" students get to know the most important classes of algebraic varieties and schemes as well as the tools for studying these objects and the mappings between them. The students apply these skills to problems of arithmetic or complex analysis. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic geometry uses and connects concepts of algebra and geometry and can be used versatilely. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic geometry and supplement one another complementarily. The following content-related competencies are pursued. Students • are familiar with commutative algebra, also in greater detail; • know the concepts of algebraic geometry, especially varieties, schemes, sheafs, bundles; • examine important examples like elliptic curves, Abelian varieties or algebraic groups; • use divisors for classification questions; • study algebraic curves; • prove the Riemann-Roch theorem and apply it; • use cohomological concepts and know the basics of Hodge theory; • apply methods of algebraic geometry to arithmetical questions and obtain e. g. finiteness principles for rational points; • classify singularities and know the significant aspects of the dimension theory of commutative algebra and algebraic geometry; • get to know connections to complex analysis and to complex geometry. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Algebraic geometry""; • prepare substantial ideas of proof in the area "Algebraic geometry"".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Algebraic geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3321
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3321 "Advances in algebraic geometry"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4522: Specialisation in algebraic number theory**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Algebraic number theory" enables students to learn methods, concepts, theories and applications in the areas "Algebraic number theory" and "Algorithmic number theory". During the course of the cycle students will be successively introduced to current theoretical and/or applied research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued in relation to algebra. Students • know Noetherian and Dedekind rings and the class groups; • are familiar with discriminants, differents and bifurcation theory of Hilbert; • know geometrical number theory with applications to the unit theorem and the finiteness of class groups as well as the algorithmic aspects of lattice theory (LLL); • are familiar with L-series and zeta functions and discuss the algebraic meaning of their residues; • know densities, the Tchebotarew theorem and applications; • work with orders, S-integers and S-units; • know the class field theory of Hilbert, Takagi and Idele theoretical field theory; • are familiar with Zp-extensions and their Iwasawa theory; • discuss the most important hypotheses of Iwasawa theory and their consequences. Concerning algorithmic aspects of number theory, the following competencies are pursued. Students • work with algorithms for the identification of short lattice bases, nearest points in lattices and the shortest vectors; • are familiar with basic algorithms of number theory in long arithmetic like GCD, fast number and polynomial arithmetic, interpolation and evaluation and prime number tests; • use the sieving method for factorisation and calculation of discrete logarithms in finite fields of great characteristics; • discuss algorithms for the calculation of the zeta function of elliptic curves and Abelian varieties of finite fields; • calculate class groups and fundamental units; • calculate Galois groups of absolute number fields. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Algebraic number theory"; • prepare substantial ideas of proof in the area "Algebraic number theory".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Algebraic number theory"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3322
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3322 "Advances in algebraic number theory"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4523: Specialisation in algebraic structures**	9 C 6 WLH
Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic structures" students get to know different algebraic structures, amongst others Lie algebras, Lie groups, analytical groups, associative algebras as well as the tools from algebra, geometry and category theory that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic structures use concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic structures and supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts like rings, modules, algebras and Lie algebras; • know important examples of Lie algebras and algebras; • know special classes of Lie groups and their special characteristics; • know classification theorems for finite-dimensional algebras; • apply basic concepts of category theory to algebras and modules; • know group actions and their basic classifications; • apply the enveloping algebra of Lie algebras; • apply ring and module theory to basic constructs of algebraic geometry; • use combinatorial tools for the study of associative algebras and Lie algebras; • acquire solid knowledge of the representation theory of Lie algebras, finite groups and compact Lie groups as well as the representation theory of semisimple Lie groups; • know Hopf algebras as well as their deformation and representation theory. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Algebraic structures"; • prepare substantial ideas of proof in the area "Algebraic structures".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Algebraic structures"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3323
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3323 "Advances in algebraic structures"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Mat.4524: Specialisation in groups, geometry and dynamical systems</td><td>9 C
6 WLH</td></tr>
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Learning outcome, core skills:
Learning outcome:

In the modules of the cycle "Groups, geometry and dynamical systems" students get to know the most important classes of groups as well as the algebraic, geometrical and analytical tools that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis.

Group theory uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of the area "Groups, geometry and dynamical systems" that supplement one another complementarily. The following content-related competencies are pursued. Students

- know basic concepts of groups and group homomorphisms;
- know important examples of groups;
- know special classes of groups and their special characteristics;
- apply basic concepts of category theory to groups and define spaces via universal properties;
- apply the concepts of functors to obtain algebraic invariants;
- know group actions and their basic classification results;
- know the basics of group cohomology and compute these for important examples;
- know the basics of geometrical group theory like growth characteristics;
- know self-similar groups, their basic constructs as well as examples with interesting characteristics;
- use geometrical and combinatorial tools for the study of groups;
- know the basics of the representation theory of compact Lie groups.

Core skills:

After having successfully completed the module, students will be able to

- enhance concepts and methods for special problems and applications in the area "Groups, geometry and dynamical systems";
- prepare substantial ideas of proof in the area "Groups, geometry and dynamical systems".

</td><td>Workload:
Attendance time:
84 h
Self-study time:
186 h</td></tr>
</table>

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Groups, geometry and dynamical systems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3324
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3324 "Advances in groups, geometry and dynamical systems"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4525: Specialisation in non-commutative geometry	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

In the modules of the cycle "Non-commutative geometry" students get to know the conception of space of non-commutative geometry and some of its applications in geometry, topology, mathematical physics, the theory of dynamical systems and number theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis.

Non-commutative geometry uses concepts of analysis, algebra, geometry and mathematical physics and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of non-commutative geometry that supplement one another complementarily. The following content-related competencies are pursued. Students

- are familiar with the basic characteristics of operator algebras, especially with their representation and ideal theory;
- construct groupoids and operator algebras from different geometrical objects and apply non-commutative geometry to these domains;
- know the spectral theory of commutative C*-algebras and analyse normal operators in Hilbert spaces with it;
- know important examples of simple C*-algebras and deduce their basic characteristics;
- apply basic concepts of category theory to C*-algebras;
- model the symmetries of non-commutative spaces;
- apply Hilbert modules in C*-algebras;
- know the definition of the K-theory of C*-algebras and their formal characteristics and calculate the K-theory of C*-algebras for important examples with it;
- apply operator algebras for the formulation and analysis of index problems in geometry and for the analysis of the geometry of greater length scales;
- compare different analytical and geometrical models for the construction of mappings between K-theory groups and apply them;
- classify and analyse quantisations of manifolds via Poisson structures and know a few important methods for the construction of quantisations;
- classify W*-algebras and know the intrinsic dynamic of factors;
- apply von Neumann algebras to the axiomatic formulation of quantum field theory;
- use von Neumann algebras for the construction of L2 invariants for manifolds and groups;
- understand the connection between the analysis of C*- and W*-algebras of groups and geometrical characteristics of groups;
- define the invariants of algebras and modules with chain complexes and their homology and calculate these;

Workload:
Attendance time:
84 h
Self-study time:
186 h

• interpret these homological invariants geometrically and correlate them with each other; • abstract new concepts from the fundamental characteristics of K-theory and other homology theories, e. g. triangulated categories. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Non-commutative geometry"; • prepare substantial ideas of proof in the area "Non-commutative geometry".	

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Non-commutative geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3325
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3325 "Advances in non-commutative geometry"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations:
Instructor: Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4531: Specialisation in inverse problems	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Inverse problems" enables students to learn methods, concepts, theories and applications in the area of "Inverse problems". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the phenomenon of illposedness and identify the degree of illposedness of typical inverse problems; • evaluate different regularisation methods for ill posed inverse problems under algorithmic aspects and with regard to various a priori information and distinguish concepts of convergence for such methods with deterministic and stochastic data errors; • analyse the convergence of regularisation methods with the help of spectral theory of bounded self-adjoint operators; • analyse the convergence of regularisation methods with the help of complex analysis; • analyse regularisation methods from stochastic error models; • apply fully data-driven models for the choice of regularisation parameters and evaluate these for concrete problems; • model identification problems in natural sciences and technology as inverse problems of partial differential equations where the unknown is e. g. a coefficient, an initial or a boundary condition or the shape of a region; • analyse the uniqueness and conditional stability of inverse problems of partial differential equations; • deduce sampling and testing methods for the solution of inverse problems of partial differential equations and analyse the convergence of such methods; • formulate mathematical models of medical imaging like computer tomography (CT) or magnetic resonance tomography (MRT) and know the basic characteristics of corresponding operators. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Inverse problems"; • prepare substantial ideas of proof in the area "Inverse problems".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Inverse problems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3331
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3331 "Advances in inverse problems"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4532: Specialisation in approximation methods**	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Approximation methods" enables students to learn methods, concepts, theories and applications in the area of "Approximation methods", so the approximation of one- and multidimensional functions as well as for the analysis and approximation of discrete signals and images. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of approximation problems in suitable finite- and infinite-dimensional vector spaces; • can confidently handle models for the approximation of one- and multidimensional functions in Banach and Hilbert spaces; • know and use parts of classical approximation theory, e. g. Jackson and Bernstein theorems for the approximation quality for trigonometrical polynomials, approximation in translationally invariant spaces; polynomial reductions and Strang-Fix conditions; • acquire knowledge of continuous and discrete approximation problems and their corresponding solution strategies both in the one- and multidimensional case; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods for the efficient solution of the approximation problems on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear approximation methods for multidimensional data; • are informed about current developments of efficient data approximation and data analysis; • adapt solution strategies for the data approximation using special structural characteristics of the approximation problem that should be solved. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Approximation methods"; • prepare substantial ideas of proof in the area "Approximation methods".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Approximation methods"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3332
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3332 "Advances in approximation methods"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4533: Specialisation in numerical methods of partial differential equations	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Numerics of partial differential equations" enables students to learn methods, concepts, theories and applications in the area of "Numerics of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with the theory of linear partial differential equations, e. g. questions of classification as well as existence, uniqueness and regularity of the solution;
- know the basics of the theory of linear integral equations;
- are familiar with basic methods for the numerical solution of linear partial differential equations with finite difference methods (FDM), finite element methods (FEM) as well as boundary element methods (BEM);
- analyse stability, consistence and convergence of FDM, FEM and BEM for linear problems;
- apply methods for adaptive lattice refinement on the basis of a posteriori error approximations;
- know methods for the solution of larger systems of linear equations and their preconditioners and parallelisation;
- apply methods for the solution of larger systems of linear and stiff ordinary differential equations and are familiar with the problem of differential algebraic problems;
- apply available software for the solution of partial differential equations and evaluate the results sceptically;
- evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time;
- acquire advanced knowledge in the theory as well as development and application of numerical solution strategies in a special area of partial differential equations, e. g. in variation problems with constraints, singularly perturbed problems or of integral equations;
- know propositions about the theory of non-linear partial differential equations of monotone and maximally monotone type as well as suitable iterative solution methods.

Core skills:

After having successfully completed the module, students will be able to

- enhance concepts and methods for special problems and applications in the area "Numerics of partial differential equations";

Workload:

Attendance time:

84 h

Self-study time:

186 h

• prepare substantial ideas of proof in the area "Numerics of partial differential equations".	

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Numerical methods of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3333
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3333 "Advances in numerical methods of partial differential equations"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4534: Specialisation in optimisation	9 C 6 WLH

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Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Optimisation" enables students to learn methods, concepts, theories and applications in the area of "Optimisation", so the discrete and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- identify optimisation problems in application-oriented problems and formulate these as mathematical programmes;
- evaluate the existence and uniqueness of the solution of an optimisation problem;
- identify structural characteristics of an optimisation problem, amongst others the existence of a finite candidate set, the structure of the underlying level set;
- know which special characteristics of the target function and the constraints (like (virtual) convexity, dc functions) for the development of solution strategies can be utilised;
- analyse the complexity of an optimisation problem;
- classify a mathematical programme in a class of optimisation problems and know current solution strategies for it;
- develop optimisation methods and adapt general methods to special problems;
- deduce upper and lower bounds for optimisation problems and understand their meaning;
- understand the geometrical structure of an optimisation problem and apply it for solution strategies;
- distinguish between proper solution methods, approximation methods with quality guarantee and heuristics and evaluate different methods on the basis of the quality of the found solutions and their computing times;
- acquire advanced knowledge in the development of solution strategies on the basis of a special area of optimisation, e. g. integer optimisation, optimisation of networks or convex optimisation;
- acquire advanced knowledge for the solution of special optimisation problems of an application-oriented area, e. g. traffic planning or location planning;
- handle advanced optimisation problems, like e. g. optimisation problems with uncertainty or multi-criteria optimisation problems.

Core skills:

After having successfully completed the module, students will be able to

- enhance concepts and methods for special problems and applications in the area "Optimisation";
- prepare substantial proof ideas in the area "Optimisation".

</td>
<td>

Workload:

Attendance time:
84 h
Self-study time:
186 h

</td>
</tr>
</table>

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Optimisation"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3334
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3334 "Advances in optimisation"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4537: Specialisation in variational analysis	9 C 6 WLH

Learning outcome, core skills:	Workload:
Learning outcome: The successful completion of modules of the cycle "Variational analysis" enables students to learn methods, concepts, theories and applications in variational analysis and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • understand basic concepts of convex and variational analysis for finite- and infinite-dimensional problems; • master the characteristics of convexity and other concepts of the regularity of sets and functions to evaluate the existence and regularity of the solutions of variational problems; • understand basic concepts of the convergence of sets and continuity of set-valued functions; • understand basic concepts of variational geometry; • calculate and use generalised derivations (subderivatives and subgradients) of non-smooth functions; • understand the different concepts of regularity of set-valued functions and their effects on the calculation rules for subderivatives of non-convex functionals; • analyse constrained and parametric optimisation problems with the help of duality theory; • calculate and use the Legendre-Fenchel transformation and infimal convulutions; • formulate optimality criteria for continuous optimisation problems with tools of convex and variational analysis; • apply tools of convex and variational analysis to solve generalised inclusions that e. g. originate from first-order optimality criteria; • understand the connection between convex functions and monotone operators; • examine the convergence of fixed point iterations with the help of the theory of monotone operators; • deduce methods for the solution of smooth and non-smooth continuous constrained optimisation problems and analyse their convergence; • apply numerical methods for the solution of smooth and non-smooth continuous constrained programs to current problems; • model application problems with variational inequations, analyse their characteristics and are familiar with numerical methods for the solution of variational inequations; • know applications of control theory and apply methods of dynamic programming; • use tools of variational analysis in image processing and with inverse problems; • know basic concepts and methods of stochastic optimisation. **Core skills:**	Attendance time: 84 h Self-study time: 186 h

After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Variational analysis"; • prepare substantial ideas of proof in the area "Variational analysis".	

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Variational analysis"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3337
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3337 "Advances in variational analysis"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4538: Specialisation in image and geometry processing	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Image and geometry processing" enables students to learn and apply methods, concepts, theories and applications in the area of "Image and geometry processing", so the digital image and geometry processing. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e.g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of problems of image and geometry processing in suitable finite- and infinite-dimensional vector spaces; • learn basic methods for the analysis of one- and multidimensional functions in Banach and Hilbert spaces; • learn basic mathematical concepts and methods that are used in image processing, like Fourier and Wavelet transform; • learn basic mathematical concepts and methods that play a central role in geometry processing, like curvature of curves and surfaces; • acquire knowledge about continuous and discrete problems of image data analysis and their corresponding solution strategies; • know basic concepts and methods of topology; • are familiar with visualisation software; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • know which special characteristics of an image or of a geometry can be extracted and worked on with which methods; • evaluate different numerical methods for the efficient analysis of multidimensional data on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear methods for the geometrical and topological analysis of multidimensional data; • are informed about current developments of efficient geometrical and topological data analysis; • adapt solution strategies for the data analysis using special structural characteristics of the given multidimensional data. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Image and geometry processing"; • prepare substantial ideas of proof in the area "Image and geometry processing".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Image and geometry processing"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3338
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3338 "Advances in image and geometry processing"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4539: Specialisation in scientific computing / applied mathematics**	9 C 6 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Scientific computing / applied mathematics" enables students to learn and apply methods, concepts, theories and applications in the area of "Scientific computing / applied mathematics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of basic mathematical models of the corresponding subject area, especially about the existence and uniqueness of solutions; • know basic methods for the numerical solution of these models; • analyse stability, convergence and efficiency of numerical solution strategies; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • are informed about current developments of scientific computing, like e. g. GPU computing and use available soft- and hardware; • use methods of scientific computing for solving application problems, like e. g. of natural and business sciences. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Scientific computing / applied mathematics"; • prepare substantial ideas of proof in the area "Scientific computing / applied mathematics".	**Workload:** Attendance time: 84 h Self-study time: 186 h
Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C
Course: Exercise session (Exercise)	2 WLH
Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Scientific computing / applied mathematics	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3339
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3339 "Advances in scientific computing / applied mathematics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4541: Specialisation in applied and mathematical stochastics**	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Applied and mathematical stochastics" enables students to understand and apply a broad range of problems, theories, modelling and proof techniques of stochastics. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued: Students • are familiar with advanced concepts of probability theory established on measure theory and apply them independently; • are familiar with substantial concepts and approaches of probability modelling and inferential statistics; • know basic characteristics of stochastic processes as well as conditions for their existence and uniqueness; • have a pool of different stochastic processes in time and space at their disposal and characterise those, differentiate them and quote examples; • understand and identify basic characteristics of invariance of stochastic processes like stationary processes and isotropy; • analyse the convergence characteristic of stochastic processes; • analyse regularity characteristics of the paths of stochastic processes; • adequately model temporal and spatial phenomena in natural and economicsciences as stochastic processes, if necessary with unknown parameters; • analyse probabilistic and statistic models regarding their typical characteristics, estimate unknown parameters and make predictions for their paths on areas not observed / at times not observed; • discuss and compare different modelling approaches and evaluate the reliability of parameter estimates and predictions sceptically. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Applied and mathematical stochastics"; • prepare substantial ideas of proof in the area "Applied and mathematical stochastics".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Applied and mathematical stochastics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3341
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3341 "Advances in applied and mathematical stochastics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4542: Specialisation in stochastic processes	9 C 6 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Stochastic processes" enables students to learn and apply methods, concepts, theories and proof techniques in the area of "Stochastic processes" and use these for the modelling of stochastic systems. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with advanced concepts of probability theory established on measure theory and apply them independently;
- know basic characteristics as well as existence and uniqueness results for stochastic processes and formulate suitable probability spaces;
- understand the relevance of the concepts of filtration, conditional expectation and stopping time for the theory of stochastic processes;
- know fundamental classes of stochastic processes (like e. g. Poisson processes, Brownian motions, Levy processes, stationary processes, multivariate and spatial processes as well as branching processes) and construct and characterise these processes;
- analyse regularity characteristics of the paths of stochastic processes;
- construct Markov chains with discrete and general state spaces in discrete and continuous time, classify their states and analyse their characteristics;
- are familiar with the theory of general Markov processes and characterise and analyse these with the use of generators, semigroups, martingale problems and Dirichlet forms;
- analyse martingales in discrete and continuous time using the corresponding martingale theory, especially using martingale equations, martingale convergence theorems, martingale stopping theorems and martingale representation theorems;
- formulate stochastic integrals as well as stochastic differential equations with the use of the Ito calculus and analyse their characteristics;
- are familiar with stochastic concepts in general state spaces as well as with the topologies, metrics and convergence theorems relevant for stochastic processes;
- know fundamental convergence theorems for stochastic processes and generalise these;
- model stochastic systems from different application areas in natural sciences and technology with the aid of suitable stochastic processes;
- analyse models in mathematical economics and finance and understand evaluation methods for financial products.

Core skills:

After having successfully completed the module, students will be able to

Workload:
Attendance time:
84 h
Self-study time:
186 h

• enhance concepts and methods for special problems and applications in the area "Stochastic processes"; • prepare substantial ideas of proof in the area "Stochastic processes".	

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Stochastic processes"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3342
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3342 "Advances in stochastic processes	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4543: Specialisation in stochastic methods in economathematics**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Stochastic methods of economathematics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master problems, basic concepts and stochastic methods of economathematics; • understand stochastic connections; • understand references to other mathematical areas; • get to know possible applications in theory and practice; • gain insight into the connection of mathematics and economic sciences. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Stochastic methods of economathematics"; • prepare substantial ideas of proof in the area "Stochastic methods of economathematics".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Stochastic methods in economathematics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3343
Language: English	**Person responsible for module:** Dean of studies
Course frequency:	**Duration:** 1 semester[s]

Usually subsequent to the module B.Mat.3343 "Advances in stochastic methods in economathematics"	
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4544: Specialisation in mathematical statistics	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Mathematical statistics" enables students to learn methods, concepts, theories and applications in the area of "Mathematical statistics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of mathematical statistics like estimates, testing, confidence propositions and classification and use them in simple models of mathematical statistics; • evaluate statistical methods mathematically precisely via suitable risk and loss concepts; • analyse optimality characteristics of statistical estimate methods via lower and upper bounds; • analyse the error rates of statistical testing and classification methods based on the Neyman Pearson theory; • are familiar with basic statistical distribution models that base on the theory of exponential indexed families; • know different techniques to obtain lower and upper risk bounds in these models; • are confident in modelling typical data structures of regression; • analyse practical statistical problems in a mathematically accurate way with the techniques learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of mathematical statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Variational analysis"; • prepare substantial ideas of proof in the area "Variational analysis".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:**	9 C

Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Mathematical statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3344
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3344 "Advances in mathematical statistics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4545: Specialisation in statistical modelling and inference**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Statistical modelling and inference" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the fundamental principles of statistics and inference in parametric and non-parametric models: estimation, testing, confidence statements, prediction, model selection and validation; • are familiar with the tools of asymptotic statistical inference; • learn Bayes and frequentist approaches to data modelling and inference, as well as the interplay between both, in particular empirical Bayes methods; • are able to implement Monte Carlo statistical methods for Bayes and frequentist inference and learn their theoretical properties; • become confident in non-parametric (regression) modelling and inference for various types of the data: count, categorical, dependent, etc.; • are able to develop and mathematically evaluate complex statistical models for real data problems. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Statistical modelling and inference"; • prepare substantial ideas of proof in the area "Statistical modelling and inference".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Statistical modelling and inference"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3345

Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3345 "Advances in statistical modelling and inference"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Mat.4546: Specialisation in multivariate statistics</td><td>9 C
6 WLH</td></tr>
<tr><td>Learning outcome, core skills:
Learning outcome:
The successful completion of modules of the cycle "Multivariate statistics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

are well acquainted with the most important methods of multivariate statistics like estimation, testing, confidence statements, prediction, linear and generalized linear models, and use them in modeling real world applications;
can apply more specific methods of multivariate statistics such as dimension reduction by principal component analysis (PCA), factor analysis and multidimensional scaling;
are familiar with handling non-Euclidean data such as directional or shape data using parametric and non-parametric models;
are confident using nested descriptors for non-Euclidean data and Procrustes methods in shape analysis;
are familiar with time dependent data, basic functional data analysis and inferential concepts such as kinematic formulae;
analyze basic dependencies between topology/geometry of underlying spaces and asymptotic limiting distributions;
are confident to apply resampling methods to non-Euclidean descriptors;
are familiar with high-dimensional discrimination and classification techniques such as kernel PCA, regularization methods and support vector machines;
have a fundamental knowledge of statistics of point processes and Bayesian methods involved;
are familiar with concepts of large scale computational statistical techniques;
independently become acquainted with a current topic of multivariate and non-Euclidean statistics;
evaluate complex statistical methods and enhance them in a problem-oriented way.

Core skills:
After having successfully completed the module, students will be able to

enhance concepts and methods for special problems and applications in the area "Multivariate statistics";
prepare substantial ideas of proof in the area "Multivariate statistics".
</td><td>Workload:
Attendance time:
84 h
Self-study time:
186 h</td></tr>
</table>

<table>
<tr><td>Course: Lecture course (Lecture)</td><td>4 WLH</td></tr>
<tr><td>Examination: Oral examination (approx. 20 minutes)
Examination prerequisites:</td><td>9 C</td></tr>
</table>

Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Multivariate statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3346
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3346 "Advances in multivariate statistics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4547: Specialisation in statistical foundations of data science**	9 C 6 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Statistical foundations of data science" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of statistical foundations of data science like estimation, testing, confidence statements, prediction, resampling, pattern recognition and classification, and use them in modeling real world applications; • evaluate statistical methods mathematically precisely via suitable statistical risk and loss concepts; • analyse characteristics of statistical estimation methods via lower and upper information bounds; • are familiar with basic statistical distribution models that base on the theory of exponential families; • are confident in modelling real world data structures such as categorial data, multidimensional and high dimensional data, data in imaging, data with serial dependencies • analyse practical statistical problems in a mathematically accurate way with the techniques and models learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with concepts of large scale computational statistical techniques; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of statistical data science; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • enhance concepts and methods for special problems and applications in the area "Statistical foundations of data science"; • prepare substantial ideas of proof in the area "Statistical foundations of data science".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH

Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

Course: Exercise session (Exercise)	2 WLH

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Statistical foundations of data science"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3347
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module B.Mat.3347 "Advances in statistical foundations of data science"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4611: Aspects of analytic number theory	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Analytic number theory" enables students to learn methods, concepts, theories and applications in the area of "Analytic number theory". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • solve arithmetical problems with basic, complex-analytical, and Fourier-analytical methods; • know characteristics of the Riemann zeta function and more general L-functions, and apply them to problems of number theory; • are familiar with results and methods of prime number theory; • acquire knowledge in arithmetical and analytical theory of automorphic forms, and its application in number theory; • know basic sieving methods and apply them to the problems of number theory; • know techniques used to estimate the sum of the sum of characters and of exponentials; • analyse the distribution of rational points on suitable algebraic varieties using analytical techniques; • master computation with asymptotic formulas, asymptotic analysis, and asymptotic equipartition in number theory. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Analytic number theory"; • carry out scientific work under supervision in the area "Analytic number theory".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Analytic number theory"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3311
Language: English	**Person responsible for module:** Dean of studies
Course frequency:	**Duration:**

Usually subsequent to the module M.Mat.4511 "Specialisation in analytic number theory"	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4612: Aspects of analysis of partial differential equations**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Analysis of partial differential equations" enables students to learn methods, concepts, theories and applications in the area "Analysis of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important types of partial differential equations and know their solutions; • master the Fourier transform and other techniques of the harmonic analysis to analyse partial differential equations; • are familiar with the theory of generalized functions and the theory of function spaces and use these for solving differential partial equations; • apply the basic principles of functional analysis to the solution of partial different equations; • use different theorems of function theory for solving partial different equations; • master different asymptotic techniques to study characteristics of the solutions of partial different equations; • are paradigmatically familiar with broader application areas of linear theory of partial different equations; • are paradigmatically familiar with broader application areas of non-linear theory of partial different equations; • know the importance of partial different equations in the modelling in natural and engineering sciences; • master some advanced application areas like parts of microlocal analysis or parts of algebraic analysis. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Analysis of partial differential equations"; • carry out scientific work under supervision in the area "Analysis of partial differential equations".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Analysis of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3312
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4512 "Specialisation in analysis of partial differential equations"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4613: Aspects of differential geometry	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Differential geometry" enables students to learn methods, concepts, theories and applications in the area "Differential geometry". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master the basic concepts of differential geometry; • develop a spatial sense using the examples of curves, areas and hypersurfaces; • develop an understanding of the basic concepts of differential geometry like "space" and "manifolds", "symmetry" and "Lie group", "local structures" and "curvature", "global structure" and "invariants" as well as "integrability"; • master (variably weighted and sorted depending on the current courses offered) the theory of transformation groups and symmetries as well as the analysis on manifolds, the theory of manifolds with geometric structures, complex differential geometry, gauge field theory and their applications as well as the elliptical differential equations of geometry and gauge field theory; • develop an understanding for geometrical constructs, spatial patterns and the interaction of algebraic, geometrical, analytical and topological methods; • acquire the skill to apply methods of analysis, algebra and topology for the treatment of geometrical problems; • are able to import geometrical problems to a broader mathematical and physical context. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Differential geometry"; • carry out scientific work under supervision in the area "Differential geometry".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Differential geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3313
Language:	**Person responsible for module:**

English	Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4513 "Specialisation in differential geometry"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations:
Instructor: Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4614: Aspects of algebraic topology	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Algebraic topology" students get to know the most important classes of topological spaces as well as algebraic and analytical tools for studying these spaces and the mappings between them. The students use these tools in geometry, mathematical physics, algebra and group theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic topology uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic topology and supplement one another complementarily. The following content-related competencies are pursued. Students • know the basic concepts of set-theoretic topology and continuous mappings; • construct new topologies from given topologies; • know special classes of topological spaces and their special characteristics like CW complexes, simplicial complexes and manifolds; • apply basic concepts of category theory to topological spaces; • use concepts of functors to obtain algebraic invariants of topological spaces and mappings; • know the fundamental group and the covering theory as well as the basic methods for the computation of fundamental groups and mappings between them; • know homology and cohomology, calculate those for important examples and with the aid of these deduce non-existence of mappings as well as fixed-point theorems; • calculate homology and cohomology with the aid of chain complexes; • deduce algebraic characteristics of homology and cohomology with the aid of homological algebra; • become acquainted with connections between analysis and topology; • apply algebraic structures to deduce special global characteristics of the cohomology of a local structure of manifolds. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Algebraic topology"; • carry out scientific work under supervision in the area "Algebraic topology".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Algebraic topology"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3314
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4514 "Specialisation in algebraic topology"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4615: Aspects of mathematical methods in physics**	6 C 4 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Mathematical methods of physics" students get to know different mathematical methods and techniques that play a role in modern physics. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. The topics of the cycle can be divided into four blocks, a cycle normally contains parts of different blocks, that topically supplement each other, but can also be read within one block. The introducing parts of the cycle form the basis for the advanced specialisation area. The topic blocks are • harmonic analysis, algebraic structures and representation theory, (group) effects; • operator algebra, C* algebra and von-Neumann algebra; • operator theory, perturbation and scattering theory, special PDE, microlocal analysis, distributions; • (semi) Riemannian geometry, symplectic and Poisson geometry, quantization. One of the aims is that a connection to physical problems is visible, at least in the motivation of the covered topics. Preferably, in the advanced part of the cycle, the students should know and be able to carry out practical applications themselves. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Mathematical methods of physics"; • carry out scientific work under supervision in the area "Mathematical methods of physics".	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Mathematical methods in physics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3315
Language: English	**Person responsible for module:** Dean of studies
Course frequency:	**Duration:** 1 semester[s]

Usually subsequent to the module M.Mat.4515 "Specialisation in mathematical methods in physics"	
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations:
Instructor: Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4621: Aspects of algebraic geometry	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Algebraic geometry" students get to know the most important classes of algebraic varieties and schemes as well as the tools for studying these objects and the mappings between them. The students apply these skills to problems of arithmetic or complex analysis. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic geometry uses and connects concepts of algebra and geometry and can be used versatilely. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic geometry and supplement one another complementarily. The following content-related competencies are pursued. Students • are familiar with commutative algebra, also in greater detail; • know the concepts of algebraic geometry, especially varieties, schemes, sheafs, bundles; • examine important examples like elliptic curves, Abelian varieties or algebraic groups; • use divisors for classification questions; • study algebraic curves; • prove the Riemann-Roch theorem and apply it; • use cohomological concepts and know the basics of Hodge theory; • apply methods of algebraic geometry to arithmetical questions and obtain e. g. finiteness principles for rational points; • classify singularities and know the significant aspects of the dimension theory of commutative algebra and algebraic geometry; • get to know connections to complex analysis and to complex geometry. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Algebraic geometry""; • carry out scientific work under supervision in the area "Algebraic geometry"".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements:	
Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Algebraic geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3321
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4521 "Specialisation in algebraic geometry"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4622: Aspects of algebraic number theory	6 C 4 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Algebraic number theory" enables students to learn methods, concepts, theories and applications in the areas "Algebraic number theory" and "Algorithmic number theory". During the course of the cycle students will be successively introduced to current theoretical and/or applied research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued in relation to algebra. Students • know Noetherian and Dedekind rings and the class groups; • are familiar with discriminants, differents and bifurcation theory of Hilbert; • know geometrical number theory with applications to the unit theorem and the finiteness of class groups as well as the algorithmic aspects of lattice theory (LLL); • are familiar with L-series and zeta functions and discuss the algebraic meaning of their residues; • know densities, the Tchebotarew theorem and applications; • work with orders, S-integers and S-units; • know the class field theory of Hilbert, Takagi and Idele theoretical field theory; • are familiar with Zp-extensions and their Iwasawa theory; • discuss the most important hypotheses of Iwasawa theory and their consequences. Concerning algorithmic aspects of number theory, the following competencies are pursued. Students • work with algorithms for the identification of short lattice bases, nearest points in lattices and the shortest vectors; • are familiar with basic algorithms of number theory in long arithmetic like GCD, fast number and polynomial arithmetic, interpolation and evaluation and prime number tests; • use the sieving method for factorisation and calculation of discrete logarithms in finite fields of great characteristics; • discuss algorithms for the calculation of the zeta function of elliptic curves and Abelian varieties of finite fields; • calculate class groups and fundamental units; • calculate Galois groups of absolute number fields. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Algebraic number theory"; • carry out scientific work under supervision in the area "Algebraic number theory".	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Algebraic number theory"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3322
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4522 "Specialisation in algebraic number theory"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4623: Aspects of algebraic structures	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Algebraic structures" students get to know different algebraic structures, amongst others Lie algebras, Lie groups, analytical groups, associative algebras as well as the tools from algebra, geometry and category theory that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic structures use concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic structures and supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts like rings, modules, algebras and Lie algebras; • know important examples of Lie algebras and algebras; • know special classes of Lie groups and their special characteristics; • know classification theorems for finite-dimensional algebras; • apply basic concepts of category theory to algebras and modules; • know group actions and their basic classifications; • apply the enveloping algebra of Lie algebras; • apply ring and module theory to basic constructs of algebraic geometry; • use combinatorial tools for the study of associative algebras and Lie algebras; • acquire solid knowledge of the representation theory of Lie algebras, finite groups and compact Lie groups as well as the representation theory of semisimple Lie groups; • know Hopf algebras as well as their deformation and representation theory. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Algebraic structures"; • carry out scientific work under supervision in the area "Algebraic structures".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Algebraic structures"	

Admission requirements:	**Recommended previous knowledge:**

none	B.Mat.3323
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4523 "Specialisation in Variational Analysis"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4624: Aspects of groups, geometry and dynamical systems**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Groups, geometry and dynamical systems" students get to know the most important classes of groups as well as the algebraic, geometrical and analytical tools that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Group theory uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of the area "Groups, geometry and dynamical systems" that supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts of groups and group homomorphisms; • know important examples of groups; • know special classes of groups and their special characteristics; • apply basic concepts of category theory to groups and define spaces via universal properties; • apply the concepts of functors to obtain algebraic invariants; • know group actions and their basic classification results; • know the basics of group cohomology and compute these for important examples; • know the basics of geometrical group theory like growth characteristics; • know self-similar groups, their basic constructs as well as examples with interesting characteristics; • use geometrical and combinatorial tools for the study of groups; • know the basics of the representation theory of compact Lie groups. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Groups, geometry and dynamical systems"; • carry out scientific work under supervision in the area "Groups, geometry and dynamical systems".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements:	

Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Groups, geometry and dynamical systems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3324
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4524 "Specialisation in groups, geometry and dynamical systems"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4625: Aspects of non-commutative geometry**	6 C 4 WLH

Learning outcome, core skills:

Learning outcome:

In the modules of the cycle "Non-commutative geometry" students get to know the conception of space of non-commutative geometry and some of its applications in geometry, topology, mathematical physics, the theory of dynamical systems and number theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis.

Non-commutative geometry uses concepts of analysis, algebra, geometry and mathematical physics and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of non-commutative geometry that supplement one another complementarily. The following content-related competencies are pursued. Students

- are familiar with the basic characteristics of operator algebras, especially with their representation and ideal theory;
- construct groupoids and operator algebras from different geometrical objects and apply non-commutative geometry to these domains;
- know the spectral theory of commutative C*-algebras and analyse normal operators in Hilbert spaces with it;
- know important examples of simple C*-algebras and deduce their basic characteristics;
- apply basic concepts of category theory to C*-algebras;
- model the symmetries of non-commutative spaces;
- apply Hilbert modules in C*-algebras;
- know the definition of the K-theory of C*-algebras and their formal characteristics and calculate the K-theory of C*-algebras for important examples with it;
- apply operator algebras for the formulation and analysis of index problems in geometry and for the analysis of the geometry of greater length scales;
- compare different analytical and geometrical models for the construction of mappings between K-theory groups and apply them;
- classify and analyse quantisations of manifolds via Poisson structures and know a few important methods for the construction of quantisations;
- classify W*-algebras and know the intrinsic dynamic of factors;
- apply von Neumann algebras to the axiomatic formulation of quantum field theory;
- use von Neumann algebras for the construction of L2 invariants for manifolds and groups;
- understand the connection between the analysis of C*- and W*-algebras of groups and geometrical characteristics of groups;
- define the invariants of algebras and modules with chain complexes and their homology and calculate these;

Workload:

Attendance time:

56 h

Self-study time:

124 h

• interpret these homological invariants geometrically and correlate them with each other; • abstract new concepts from the fundamental characteristics of K-theory and other homology theories, e. g. triangulated categories. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Non-commutative geometry"; • carry out scientific work under supervision in the area "Non-commutative geometry".	

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Non-commutative geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3325
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4525 "Specialisation in non-commutative geometry"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4631: Aspects of inverse problems	6 C 4 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Inverse problems" enables students to learn methods, concepts, theories and applications in the area of "Inverse problems". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the phenomenon of illposedness and identify the degree of illposedness of typical inverse problems; • evaluate different regularisation methods for ill posed inverse problems under algorithmic aspects and with regard to various a priori information and distinguish concepts of convergence for such methods with deterministic and stochastic data errors; • analyse the convergence of regularisation methods with the help of spectral theory of bounded self-adjoint operators; • analyse the convergence of regularisation methods with the help of complex analysis; • analyse regularisation methods from stochastic error models; • apply fully data-driven models for the choice of regularisation parameters and evaluate these for concrete problems; • model identification problems in natural sciences and technology as inverse problems of partial differential equations where the unknown is e. g. a coefficient, an initial or a boundary condition or the shape of a region; • analyse the uniqueness and conditional stability of inverse problems of partial differential equations; • deduce sampling and testing methods for the solution of inverse problems of partial differential equations and analyse the convergence of such methods; • formulate mathematical models of medical imaging like computer tomography (CT) or magnetic resonance tomography (MRT) and know the basic characteristics of corresponding operators. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Inverse problems"; • carry out scientific work under supervision in the area "Inverse problems".	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Inverse problems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3331
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4531 "Specialisation in inverse problems"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4632: Aspects of approximation methods**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Approximation methods" enables students to learn methods, concepts, theories and applications in the area of "Approximation methods", so the approximation of one- and multidimensional functions as well as for the analysis and approximation of discrete signals and images. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of approximation problems in suitable finite- and infinite-dimensional vector spaces; • can confidently handle models for the approximation of one- and multidimensional functions in Banach and Hilbert spaces; • know and use parts of classical approximation theory, e. g. Jackson and Bernstein theorems for the approximation quality for trigonometrical polynomials, approximation in translationally invariant spaces; polynomial reductions and Strang-Fix conditions; • acquire knowledge of continuous and discrete approximation problems and their corresponding solution strategies both in the one- and multidimensional case; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods for the efficient solution of the approximation problems on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear approximation methods for multidimensional data; • are informed about current developments of efficient data approximation and data analysis; • adapt solution strategies for the data approximation using special structural characteristics of the approximation problem that should be solved. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Approximation methods"; • carry out scientific work under supervision in the area "Approximation methods".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Approximation methods"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3332
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4532 "Specialisation in approximation methods"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4633: Aspects of numerical methods of partial differential equations**	6 C 4 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Numerics of partial differential equations" enables students to learn methods, concepts, theories and applications in the area of "Numerics of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of linear partial differential equations, e. g. questions of classification as well as existence, uniqueness and regularity of the solution; • know the basics of the theory of linear integral equations; • are familiar with the basic methods for the numerical solution of linear partial differential equations with finite difference methods (FDM), finite element methods (FEM) as well as boundary element methods (BEM); • analyse stability, consistence and convergence of FDM, FEM and BEM for linear problems; • apply methods for adaptive lattice refinement on the basis of a posteriori error approximations; • know methods for the solution of larger systems of linear equations and their preconditioners and parallelisation; • apply methods for the solution of larger systems of linear and stiff ordinary differential equations and are familiar with the problem of differential algebraic problems; • apply available software for the solution of partial differential equations and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge in the theory as well as development and application of numerical solution strategies in a special area of partial differential equations, e. g. in variation problems with constraints, singularly perturbed problems or of integral equations; • know propositions about the theory of non-linear partial differential equations of monotone and maximally monotone type as well as suitable iterative solution methods. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Numerics of partial differential equations";	**Workload:** Attendance time: 56 h Self-study time: 124 h

• carry out scientific work under supervision in the area "Numerics of partial differential equations".	

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Numerical methods of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3333
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4533 "Specialisation in numerical methods of partial differential equations"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4634: Aspects of optimisation	6 C 4 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Optimisation" enables students to learn methods, concepts, theories and applications in the area of "Optimisation", so the discrete and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • identify optimisation problems in application-oriented problems and formulate these as mathematical programmes; • evaluate the existence and uniqueness of the solution of an optimisation problem; • identify structural characteristics of an optimisation problem, amongst others the existence of a finite candidate set, the structure of the underlying level set; • know which special characteristics of the target function and the constraints (like (virtual) convexity, dc functions) for the development of solution strategies can be utilised; • analyse the complexity of an optimisation problem; • classify a mathematical programme in a class of optimisation problems and know current solution strategies for it; • develop optimisation methods and adapt general methods to special problems; • deduce upper and lower bounds for optimisation problems and understand their meaning; • understand the geometrical structure of an optimisation problem and apply it for solution strategies; • distinguish between proper solution methods, approximation methods with quality guarantee and heuristics and evaluate different methods on the basis of the quality of the found solutions and their computing times; • acquire advanced knowledge in the development of solution strategies on the basis of a special area of optimisation, e. g. integer optimisation, optimisation of networks or convex optimisation; • acquire advanced knowledge for the solution of special optimisation problems of an application-oriented area, e. g. traffic planning or location planning; • handle advanced optimisation problems, like e. g. optimisation problems with uncertainty or multi-criteria optimisation problems. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Optimisation"; • carry out scientific work under supervision in the area "Optimisation".	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Optimisation"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3334
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4534 "Specialisation in optimisation"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4637: Aspects of variational analysis	6 C 4 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Variational analysis" enables students to learn methods, concepts, theories and applications in variational analysis and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • understand basic concepts of convex and variational analysis for finite- and infinite-dimensional problems; • master the characteristics of convexity and other concepts of the regularity of sets and functions to evaluate the existence and regularity of the solutions of variational problems; • understand basic concepts of the convergence of sets and continuity of set-valued functions; • understand basic concepts of variational geometry; • calculate and use generalised derivations (subderivatives and subgradients) of non-smooth functions; • understand the different concepts of regularity of set-valued functions and their effects on the calculation rules for subderivatives of non-convex functionals; • analyse constrained and parametric optimisation problems with the help of duality theory; • calculate and use the Legendre-Fenchel transformation and infimal convulutions; • formulate optimality criteria for continuous optimisation problems with tools of convex and variational analysis; • apply tools of convex and variational analysis to solve generalised inclusions that e. g. originate from first-order optimality criteria; • understand the connection between convex functions and monotone operators; • examine the convergence of fixed point iterations with the help of the theory of monotone operators; • deduce methods for the solution of smooth and non-smooth continuous constrained optimisation problems and analyse their convergence; • apply numerical methods for the solution of smooth and non-smooth continuous constrained programs to current problems; • model application problems with variational inequations, analyse their characteristics and are familiar with numerical methods for the solution of variational inequations; • know applications of control theory and apply methods of dynamic programming; • use tools of variational analysis in image processing and with inverse problems; • know basic concepts and methods of stochastic optimisation. **Core skills:**	**Workload:** Attendance time: 56 h Self-study time: 124 h

After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Variational analysis"; • carry out scientific work under supervision in the area "Variational analysis".	

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Variational analysis".	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3337
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4537 "Specialisation in Variational Analysis"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4638: Aspects of image and geometry processing	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Image and geometry processing" enables students to learn and apply methods, concepts, theories and applications in the area of "Image and geometry processing", so the digital image and geometry processing. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of problems of image and geometry processing in suitable finite- and infinite-dimensional vector spaces; • learn basic methods for the analysis of one- and multidimensional functions in Banach and Hilbert spaces; • learn basic mathematical concepts and methods that are used in image processing, like Fourier and Wavelet transform; • learn basic mathematical concepts and methods that play a central role in geometry processing, like curvature of curves and surfaces; • acquire knowledge about continuous and discrete problems of image data analysis and their corresponding solution strategies; • know basic concepts and methods of topology; • are familiar with visualisation software; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • know which special characteristics of an image or of a geometry can be extracted and worked on with which methods; • evaluate different numerical methods for the efficient analysis of multidimensional data on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear methods for the geometrical and topological analysis of multidimensional data; • are informed about current developments of efficient geometrical and topological data analysis; • adapt solution strategies for the data analysis using special structural characteristics of the given multidimensional data. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Image and geometry processing"; • carry out scientific work under supervision in the area "Image and geometry processing".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Image and geometry processing"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3338
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4538 "Specialisation in image and geometry processing"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4639: Aspects of scientific computing / applied mathematics**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Scientific computing / Applied mathematics" enables students to learn and apply methods, concepts, theories and applications in the area of "Scientific computing / Applied mathematics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of basic mathematical models of the corresponding subject area, especially about the existence and uniqueness of solutions; • know basic methods for the numerical solution of these models; • analyse stability, convergence and efficiency of numerical solution strategies; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • are informed about current developments of scientific computing, like e. g. GPU computing and use available soft- and hardware; • use methods of scientific computing for solving application problems, like e. g. of natural and business sciences. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Scientific computing / Applied mathematics"; • carry out scientific work under supervision in the area "Scientific computing / Applied mathematics".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Scientific computing / applied mathematics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3339
Language:	**Person responsible for module:**

English	Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4539 "Specialisation in scientific computing / applied mathematics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4641: Aspects of applied and mathematical stochastics**	6 C 4 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Applied and mathematical stochastics" enables students to understand and apply a broad range of problems, theories, modelling and proof techniques of stochastics. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued: Students • are familiar with advanced concepts of probability theory established on measure theory and apply them independently; • are familiar with substantial concepts and approaches of probability modelling and inferential statistics; • know basic characteristics of stochastic processes as well as conditions for their existence and uniqueness; • have a pool of different stochastic processes in time and space at their disposal and characterise those, differentiate them and quote examples; • understand and identify basic characteristics of invariance of stochastic processes like stationary processes and isotropy; • analyse the convergence characteristic of stochastic processes; • analyse regularity characteristics of the paths of stochastic processes; • adequately model temporal and spatial phenomena in natural and economic sciences as stochastic processes, if necessary with unknown parameters; • analyse probabilistic and statistic models regarding their typical characteristics, estimate unknown parameters and make predictions for their paths on areas not observed / at times not observed; • discuss and compare different modelling approaches and evaluate the reliability of parameter estimates and predictions sceptically. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Applied and mathematical stochastics"; • carry out scientific work under supervision in the area "Applied and mathematical stochastics".	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Applied and mathematical stochastics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3341
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4541 "Specialisation in applied and mathematical stochastics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4642: Aspects of stochastic processes**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Stochastic processes" enables students to learn and apply methods, concepts, theories and proof techniques in the area of "Stochastic processes" and use these for the modelling of stochastic systems. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with advanced concepts of probability theory established on measure theory and apply them independently; • know basic characteristics as well as existence and uniqueness results for stochastic processes and formulate suitable probability spaces; • understand the relevance of the concepts of filtration, conditional expectation and stopping time for the theory of stochastic processes; • know fundamental classes of stochastic processes (like e. g. Poisson processes, Brownian motions, Levy processes, stationary processes, multivariate and spatial processes as well as branching processes) and construct and characterise these processes; • analyse regularity characteristics of the paths of stochastic processes; • construct Markov chains with discrete and general state spaces in discrete and continuous time, classify their states and analyse their characteristics; • are familiar with the theory of general Markov processes and characterise and analyse these with the use of generators, semigroups, martingale problems and Dirichlet forms; • analyse martingales in discrete and continuous time using the corresponding martingale theory, especially using martingale equations, martingale convergence theorems, martingale stopping theorems and martingale representation theorems; • formulate stochastic integrals as well as stochastic differential equations with the use of the Ito calculus and analyse their characteristics; • are familiar with stochastic concepts in general state spaces as well as with the topologies, metrics and convergence theorems relevant for stochastic processes; • know fundamental convergence theorems for stochastic processes and generalise these; • model stochastic systems from different application areas in natural sciences and technology with the aid of suitable stochastic processes; • analyse models in mathematical economics and finance and understand evaluation methods for financial products. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Stochastic processes";	Attendance time: 56 h Self-study time: 124 h

• carry out scientific work under supervision in the area "Stochastic processes".	

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Stochastic processes"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3342
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4542 "Specialisation in stochastic processes"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4643: Aspects of stochastics methods of economathematics	6 C 4 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Stochastic methods of economathematics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- master problems, basic concepts and stochastic methods of economathematics;
- understand stochastic connections;
- understand references to other mathematical areas;
- get to know possible applications in theory and practice;
- gain insight into the connection of mathematics and economic sciences.

Core skills:

After having successfully completed the module, students will be able to

- conduct scholarly debates about problems of the area "Stochastic methods of economathematics";
- carry out scientific work under supervision in the area "Stochastic methods of economathematics".

Workload:
Attendance time:
56 h
Self-study time:
124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements:
Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Stochastics methods of economathematics"

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3343
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4543 "Specialisation in stochastics methods of economathematics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3

Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4644: Aspects of mathematical statistics**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Mathematical statistics" enables students to learn methods, concepts, theories and applications in the area of "Mathematical statistics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of mathematical statistics like estimates, testing, confidence propositions and classification and use them in simple models of mathematical statistics; • evaluate statistical methods mathematically precisely via suitable risk and loss concepts; • analyse optimality characteristics of statistical estimate methods via lower and upper bounds; • analyse the error rates of statistical testing and classification methods based on the Neyman Pearson theory; • are familiar with basic statistical distribution models that base on the theory of exponential indexed families; • know different techniques to obtain lower and upper risk bounds in these models; • are confident in modelling typical data structures of regression; • analyse practical statistical problems in a mathematically accurate way with the techniques learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of mathematical statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Mathematical statistics"; • carry out scientific work under supervision in the area "Mathematical statistics".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Mathematical statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3344
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4544 "Specialisation in mathematical statistics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4645: Aspects of statistical modelling and inference**	6 C 4 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Statistical modelling and inference" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the fundamental principles of statistics and inference in parametric and non-parametric models: estimation, testing, confidence statements, prediction, model selection and validation; • are familiar with the tools of asymptotic statistical inference; • learn Bayes and frequentist approaches to data modelling and inference, as well as the interplay between both, in particular empirical Bayes methods; • are able to implement Monte Carlo statistical methods for Bayes and frequentist inference and learn their theoretical properties; • become confident in non-parametric (regression) modelling and inference for various types of the data: count, categorical, dependent, etc.; • are able to develop and mathematically evaluate complex statistical models for real data problems. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Statistical modelling and inference"; • carry out scientific work under supervision in the area "Statistical modelling and inference".	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C
Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Statistical modelling and inference"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3345
Language: English	**Person responsible for module:** Dean of studies
Course frequency:	**Duration:**

Usually subsequent to the module M.Mat.4545 "Specialisation in statistical modelling and inference"	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4646: Aspects of multivariate statistics	6 C 4 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Multivariate statistics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are well acquainted with the most important methods of multivariate statistics like estimation, testing, confidence statements, prediction, linear and generalized linear models, and use them in modeling real world applications; • can apply more specific methods of multivariate statistics such as dimension reduction by principal component analysis (PCA), factor analysis and multidimensional scaling; • are familiar with handling non-Euclidean data such as directional or shape data using parametric and non-parametric models; • are confident using nested descriptors for non-Euclidean data and Procrustes methods in shape analysis; • are familiar with time dependent data, basic functional data analysis and inferential concepts such as kinematic formulae; • analyze basic dependencies between topology/geometry of underlying spaces and asymptotic limiting distributions; • are confident to apply resampling methods to non-Euclidean descriptors; • are familiar with high-dimensional discrimination and classification techniques such as kernel PCA, regularization methods and support vector machines; • have a fundamental knowledge of statistics of point processes and Bayesian methods involved; • are familiar with concepts of large scale computational statistical techniques; • independently become acquainted with a current topic of multivariate and non-Euclidean statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Multivariate statistics"; • carry out scientific work under supervision in the area "Multivariate statistics".	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Multivariate statistics"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4546
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4546 "Specialisation in multivariate statistics"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4647: Aspects of statistical foundations of data science**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Statistical foundations of data science" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of statistical foundations of data science like estimation, testing, confidence statements, prediction, resampling, pattern recognition and classification, and use them in modeling real world applications; • evaluate statistical methods mathematically precisely via suitable statistical risk and loss concepts; • analyse characteristics of statistical estimation methods via lower and upper information bounds; • are familiar with basic statistical distribution models that base on the theory of exponential families; • are confident in modelling real world data structures such as categorial data, multidimensional and high dimensional data, data in imaging, data with serial dependencies • analyse practical statistical problems in a mathematically accurate way with the techniques and models learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with concepts of large scale computational statistical techniques; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of statistical data science; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Statistical foundations of data science"; • carry out scientific work under supervision in the area "Statistical foundations of data science".	Attendance time: 56 h Self-study time: 124 h

Course: Lecture course (4 WLH); alternatively lecture course (2 WLH) with exercises/seminar (2 WLH)	4 WLH
Examination: Oral examination (approx. 20 minutes)	6 C

Examination requirements: Proof of the acquisition of special skills and the mastery of advanced competencies in the area "Statistical foundations of data science"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4547
Language: English	**Person responsible for module:** Dean of studies
Course frequency: Usually subsequent to the module M.Mat.4547 "Specialisation in statistical foundations of data science"	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4711: Special course in analytic number theory	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Analytic number theory" enables students to learn methods, concepts, theories and applications in the area of "Analytic number theory". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • solve arithmetical problems with basic, complex-analytical, and Fourier-analytical methods; • know characteristics of the Riemann zeta function and more general L-functions, and apply them to problems of number theory; • are familiar with results and methods of prime number theory; • acquire knowledge in arithmetical and analytical theory of automorphic forms, and its application in number theory; • know basic sieving methods and apply them to the problems of number theory; • know techniques used to estimate the sum of the sum of characters and of exponentials; • analyse the distribution of rational points on suitable algebraic varieties using analytical techniques; • master computation with asymptotic formulas, asymptotic analysis, and asymptotic equipartition in number theory. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Analytic number theory"; • become acquainted with special problems in the area "Analytic number theory" to carry out scientific work for it.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Analytic number theory"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3311
Language: English	**Person responsible for module:** Dean of studies
Course frequency:	**Duration:**

not specified	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4712: Special course in analysis of partial differential equations**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Analysis of partial differential equations" enables students to learn methods, concepts, theories and applications in the area "Analysis of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important types of partial differential equations and know their solutions; • master the Fourier transform and other techniques of the harmonic analysis to analyse partial differential equations; • are familiar with the theory of generalised functions and the theory of function spaces and use these for solving differential partial equations; • apply the basic principles of functional analysis to the solution of partial different equations; • use different theorems of function theory for solving partial different equations; • master different asymptotic techniques to study characteristics of the solutions of partial different equations; • are paradigmatically familiar with broader application areas of linear theory of partial different equations; • are paradigmatically familiar with broader application areas of non-linear theory of partial different equations; • know the importance of partial different equations in the modelling in natural and engineering sciences; • master some advanced application areas like parts of microlocal analysis or parts of algebraic analysis. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Analysis of partial differential equations"; • become acquainted with special problems in the area "Analysis of partial differential equations" to carry out scientific work for it.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements:	

Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Analysis of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3312
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4713: Special course in differential geometry**	3 C 2 WLH

<table>
<tr><td>Learning outcome, core skills:
Learning outcome:
The successful completion of modules of the cycle "Differential geometry" enables students to learn methods, concepts, theories and applications in the area "Differential geometry". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

master the basic concepts of differential geometry;
develop a spatial sense using the examples of curves, surfaces and hypersurfaces;
develop an understanding of the basic concepts of differential geometry like "space" and "manifolds", "symmetry" and "Lie group", "local structures" and "curvature", "global structure" and "invariants" as well as "integrability";
master (variably weighted and sorted depending on the current courses offered) the theory of transformation groups and symmetries as well as the analysis on manifolds, the theory of manifolds with geometric structures, complex differential geometry, gauge field theory and their applications as well as the elliptical differential equations of geometry and gauge field theory;
develop an understanding for geometrical constructs, spatial patterns and the interaction of algebraic, geometrical, analytical and topological methods;
acquire the skill to apply methods of analysis, algebra and topology for the treatment of geometrical problems;
are able to import geometrical problems to a broader mathematical and physical context.

Core skills:
After having successfully completed the module, students will be able to

conduct scholarly debates about problems of the area "Differential geometry";
become acquainted with special problems in the area "Differential geometry" to carry out scientific work for it.
</td>
<td>Workload:
Attendance time:
28 h
Self-study time:
62 h</td></tr>
</table>

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Differential geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3313

Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4714: Special course in algebraic topology	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Algebraic topology" students get to know the most important classes of topological spaces as well as algebraic and analytical tools for studying these spaces and the mappings between them. The students use these tools in geometry, mathematical physics, algebra and group theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic topology uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic topology and supplement one another complementarily. The following content-related competencies are pursued. Students • know the basic concepts of set-theoretic topology and continuous mappings; • construct new topologies from given topologies; • know special classes of topological spaces and their special characteristics like CW complexes, simplicial complexes and manifolds; • apply basic concepts of category theory to topological spaces; • use concepts of functors to obtain algebraic invariants of topological spaces and mappings; • know the fundamental group and the covering theory as well as the basic methods for the computation of fundamental groups and mappings between them; • know homology and cohomology, calculate those for important examples and with the aid of these deduce non-existence of mappings as well as fixed-point theorems; • calculate homology and cohomology with the aid of chain complexes; • deduce algebraic characteristics of homology and cohomology with the aid of homological algebra; • become acquainted with connections between analysis and topology; • apply algebraic structures to deduce special global characteristics of the cohomology of a local structure of manifolds. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Algebraic topology"; • become acquainted with special problems in the area "Algebraic topology" to carry out scientific work for it.	Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Algebraic topology"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3314
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4715: Special course in mathematical methods in physics**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Mathematical methods of physics" students get to know different mathematical methods and techniques that play a role in modern physics. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. The topics of the cycle can be divided into four blocks, a cycle normally contains parts of different blocks, that topically supplement each other, but can also be read within one block. The introducing parts of the cycle form the basis for the advanced specialisation area. The topic blocks are • harmonic analysis, algebraic structures and representation theory, (group) effects; • operator algebra, C* algebra and von-Neumann algebra; • operator theory, perturbation and scattering theory, special PDE, microlocal analysis, distributions; • (semi) Riemannian geometry, symplectic and Poisson geometry, quantization. One of the aims is that a connection to physical problems is visible, at least in the motivation of the covered topics. Preferably, in the advanced part of the cycle, the students should know and be able to carry out practical applications themselves. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Mathematical methods of physics"; • become acquainted with special problems in the area "Mathematical methods of physics" to carry out scientific work for it.	Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements:	
Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Mathematical methods in physics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3315
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]

Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4721: Special course in algebraic geometry	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic geometry" students get to know the most important classes of algebraic varieties and schemes as well as the tools for studying these objects and the mappings between them. The students apply these skills to problems of arithmetic or complex analysis. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic geometry uses and connects concepts of algebra and geometry and can be used versatilely. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic geometry and supplement one another complementarily. The following content-related competencies are pursued. Students • are familiar with commutative algebra, also in greater detail; • know the concepts of algebraic geometry, especially varieties, schemes, sheafs, bundles; • examine important examples like elliptic curves, Abelian varieties or algebraic groups; • use divisors for classification questions; • study algebraic curves; • prove the Riemann-Roch theorem and apply it; • use cohomological concepts and know the basics of Hodge theory; • apply methods of algebraic geometry to arithmetical questions and obtain e. g. finiteness principles for rational points; • classify singularities and know the significant aspects of the dimension theory of commutative algebra and algebraic geometry; • get to know connections to complex analysis and to complex geometry. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Algebraic geometry"; • become acquainted with special problems in the area "Algebraic geometry" to carry out scientific work for it.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C
Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Algebraic geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3321
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Mat.4722: Special course in algebraic number theory</td><td>3 C
2 WLH</td></tr>
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Learning outcome, core skills:
Learning outcome:

The successful completion of modules of the cycle "Algebraic number theory" enables students to learn methods, concepts, theories and applications in the areas "Algebraic number theory" and "Algorithmic number theory". During the course of the cycle students will be successively introduced to current theoretical and/or applied research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued in relation to algebra. Students

- know Noetherian and Dedekind rings and the class groups;
- are familiar with discriminants, differents and bifurcation theory of Hilbert;
- know geometrical number theory with applications to the unit theorem and the finiteness of class groups as well as the algorithmic aspects of lattice theory (LLL);
- are familiar with L-series and zeta functions and discuss the algebraic meaning of their residues;
- know densities, the Tchebotarew theorem and applications;
- work with orders, S-integers and S-units;
- know the class field theory of Hilbert, Takagi and Idele theoretical field theory;
- are familiar with Zp-extensions and their Iwasawa theory;
- discuss the most important hypotheses of Iwasawa theory and their consequences.

Concerning algorithmic aspects of number theory, the following competencies are pursued. Students

- work with algorithms for the identification of short lattice bases, nearest points in lattices and the shortest vectors;
- are familiar with basic algorithms of number theory in long arithmetic like GCD, fast number and polynomial arithmetic, interpolation and evaluation and prime number tests;
- use the sieving method for factorisation and calculation of discrete logarithms in finite fields of great characteristics;
- discuss algorithms for the calculation of the zeta function of elliptic curves and Abelian varieties of finite fields;
- calculate class groups and fundamental units;
- calculate Galois groups of absolute number fields.

Core skills:

After having successfully completed the module, students will be able to

- conduct scholarly debates about problems of the area "Algebraic number theory";
- become acquainted with special problems in the area "Algebraic number theory" to carry out scientific work for it.

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Workload:
Attendance time:
28 h
Self-study time:
62 h

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</table>

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Algebraic number theory	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3322
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4723: Special course in algebraic structures	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Algebraic structures" students get to know different algebraic structures, amongst others Lie algebras, Lie groups, analytical groups, associative algebras as well as the tools from algebra, geometry and category theory that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic structures use concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic structures and supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts like rings, modules, algebras and Lie algebras; • know important examples of Lie algebras and algebras; • know special classes of Lie groups and their special characteristics; • know classification theorems for finite-dimensional algebras; • apply basic concepts of category theory to algebras and modules; • know group actions and their basic classifications; • apply the enveloping algebra of Lie algebras; • apply ring and module theory to basic constructs of algebraic geometry; • use combinatorial tools for the study of associative algebras and Lie algebras; • acquire solid knowledge of the representation theory of Lie algebras, finite groups and compact Lie groups as well as the representation theory of semisimple Lie groups; • know Hopf algebras as well as their deformation and representation theory. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Algebraic structures"; • become acquainted with special problems in the area "Algebraic structures" to carry out scientific work for it.	Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Algebraic structures"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3323
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4724: Special course in groups, geometry and dynamical systems**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Groups, geometry and dynamical systems" students get to know the most important classes of groups as well as the algebraic, geometrical and analytical tools that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Group theory uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of the area "Groups, geometry and dynamical systems" that supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts of groups and group homomorphisms; • know important examples of groups; • know special classes of groups and their special characteristics; • apply basic concepts of category theory to groups and define spaces via universal properties; • apply the concepts of functors to obtain algebraic invariants; • know group actions and their basic classification results; • know the basics of group cohomology and compute these for important examples; • know the basics of geometrical group theory like growth characteristics; • know self-similar groups, their basic constructs as well as examples with interesting characteristics; • use geometrical and combinatorial tools for the study of groups; • know the basics of the representation theory of compact Lie groups. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Groups, geometry and dynamical systems"; • become acquainted with special problems in the area "Groups, geometry and dynamical systems" to carry out scientific work for it.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements:	

Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Groups, geometry and dynamical systems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3324
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4725: Special course in non-commutative geometry	3 C 2 WLH

Learning outcome, core skills:

Learning outcome:

In the modules of the cycle "Non-commutative geometry" students get to know the conception of space of non-commutative geometry and some of its applications in geometry, topology, mathematical physics, the theory of dynamical systems and number theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis.

Non-commutative geometry uses concepts of analysis, algebra, geometry and mathematical physics and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of non-commutative geometry that supplement one another complementarily. The following content-related competencies are pursued. Students

- are familiar with the basic characteristics of operator algebras, especially with their representation and ideal theory;
- construct groupoids and operator algebras from different geometrical objects and apply non-commutative geometry to these domains;
- know the spectral theory of commutative C*-algebras and analyse normal operators in Hilbert spaces with it;
- know important examples of simple C*-algebras and deduce their basic characteristics;
- apply basic concepts of category theory to C*-algebras;
- model the symmetries of non-commutative spaces;
- apply Hilbert modules in C*-algebras;
- know the definition of the K-theory of C*-algebras and their formal characteristics and calculate the K-theory of C*-algebras for important examples with it;
- apply operator algebras for the formulation and analysis of index problems in geometry and for the analysis of the geometry of greater length scales;
- compare different analytical and geometrical models for the construction of mappings between K-theory groups and apply them;
- classify and analyse quantisations of manifolds via Poisson structures and know a few important methods for the construction of quantisations;
- classify W*-algebras and know the intrinsic dynamic of factors;
- apply von Neumann algebras to the axiomatic formulation of quantum field theory;
- use von Neumann algebras for the construction of L2 invariants for manifolds and groups;
- understand the connection between the analysis of C*- and W*-algebras of groups and geometrical characteristics of groups;
- define the invariants of algebras and modules with chain complexes and their homology and calculate these;

Workload:

Attendance time:
28 h

Self-study time:
62 h

• interpret these homological invariants geometrically and correlate them with each other; • abstract new concepts from the fundamental characteristics of K-theory and other homology theories, e. g. triangulated categories. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Non-commutative geometry"; • become acquainted with special problems in the area "Non-commutative geometry" to carry out scientific work for it.	

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Non-commutative geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3325
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4731: Special course in inverse problems**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Inverse problems" enables students to learn methods, concepts, theories and applications in the area of "Inverse problems". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the phenomenon of illposedness and identify the degree of illposedness of typical inverse problems; • evaluate different regularisation methods for ill posed inverse problems under algorithmic aspects and with regard to various a priori information and distinguish concepts of convergence for such methods with deterministic and stochastic data errors; • analyse the convergence of regularisation methods with the help of spectral theory of bounded self-adjoint operators; • analyse the convergence of regularisation methods with the help of complex analysis; • analyse regularisation methods from stochastic error models; • apply fully data-driven models for the choice of regularisation parameters and evaluate these for concrete problems; • model identification problems in natural sciences and technology as inverse problems of partial differential equations where the unknown is e. g. a coefficient, an initial or a boundary condition or the shape of a region; • analyse the uniqueness and conditional stability of inverse problems of partial differential equations; • deduce sampling and testing methods for the solution of inverse problems of partial differential equations and analyse the convergence of such methods; • formulate mathematical models of medical imaging like computer tomography (CT) or magnetic resonance tomography (MRT) and know the basic characteristics of corresponding operators. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Inverse problems"; • become acquainted with special problems in the area "Inverse problems" to carry out scientific work for it.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements:	

Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Inverse problems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3331
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4732: Special course in approximation methods**	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Approximation methods" enables students to learn methods, concepts, theories and applications in the area of "Approximation methods", so the approximation of one- and multidimensional functions as well as for the analysis and approximation of discrete signals and images. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of approximation problems in suitable finite- and infinite-dimensional vector spaces; • can confidently handle models for the approximation of one- and multidimensional functions in Banach and Hilbert spaces; • know and use parts of classical approximation theory, e. g. Jackson and Bernstein theorems for the approximation quality for trigonometrical polynomials, approximation in translationally invariant spaces; polynomial reductions and Strang-Fix conditions; • acquire knowledge of continuous and discrete approximation problems and their corresponding solution strategies both in the one- and multidimensional case; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods for the efficient solution of the approximation problems on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear approximation methods for multidimensional data; • are informed about current developments of efficient data approximation and data analysis; • adapt solution strategies for the data approximation using special structural characteristics of the approximation problem that should be solved. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Approximation methods"; • become acquainted with special problems in the area "Approximation methods" to carry out scientific work for it.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Approximation methods"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3332
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4733: Special course in numerical methods of partial differential equations**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Numerics of partial differential equations" enables students to learn methods, concepts, theories and applications in the area of "Numerics of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of linear partial differential equations, e. g. questions of classification as well as existence, uniqueness and regularity of the solution; • know the basics of the theory of linear integral equations; • are familiar with basic methods for the numerical solution of linear partial differential equations with finite difference methods (FDM), finite element methods (FEM) as well as boundary element methods (BEM); • analyse stability, consistence and convergence of FDM, FEM and BEM for linear problems; • apply methods for adaptive lattice refinement on the basis of a posteriori error approximations; • know methods for the solution of larger systems of linear equations and their preconditioners and parallelisation; • apply methods for the solution of larger systems of linear and stiff ordinary differential equations and are familiar with the problem of differential algebraic problems; • apply available software for the solution of partial differential equations and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge in the theory as well as development and application of numerical solution strategies in a special area of partial differential equations, e. g. in variation problems with constraints, singularly perturbed problems or of integral equations; • know propositions about the theory of non-linear partial differential equations of monotone and maximally monotone type as well as suitable iterative solution methods. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Variational analysis"; • become acquainted with special problems in the area "Variational analysis" to carry out scientific work for it.	Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area Numerical nethods of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3333
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4734: Special course in optimisation	3 C 2 WLH

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Learning outcome, core skills:
Learning outcome:

The successful completion of modules of the cycle "Optimisation" enables students to learn methods, concepts, theories and applications in the area of "Optimisation", so the discrete and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- identify optimisation problems in application-oriented problems and formulate these as mathematical programmes;
- evaluate the existence and uniqueness of the solution of an optimisation problem;
- identify structural characteristics of an optimisation problem, amongst others the existence of a finite candidate set, the structure of the underlying level set;
- know which special characteristics of the target function and the constraints (like (virtual) convexity, dc functions) for the development of solution strategies can be utilised;
- analyse the complexity of an optimisation problem;
- classify a mathematical programme in a class of optimisation problems and know current solution strategies for it;
- develop optimisation methods and adapt general methods to special problems;
- deduce upper and lower bounds for optimisation problems and understand their meaning;
- understand the geometrical structure of an optimisation problem and apply it for solution strategies;
- distinguish between proper solution methods, approximation methods with quality guarantee and heuristics and evaluate different methods on the basis of the quality of the found solutions and their computing times;
- acquire advanced knowledge in the development of solution strategies on the basis of a special area of optimisation, e. g. integer optimisation, optimisation of networks or convex optimisation;
- acquire advanced knowledge for the solution of special optimisation problems of an application-oriented area, e. g. traffic planning or location planning;
- handle advanced optimisation problems, like e. g. optimisation problems with uncertainty or multi-criteria optimisation problems.

Core skills:

After having successfully completed the module, students will be able to

- conduct scholarly debates about problems of the area "Optimisation";
- become acquainted with special problems in the area "Optimisation" to carry out scientific work for it.

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Workload:
Attendance time:
28 h
Self-study time:
62 h

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Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Optimisation"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3334
Language: English	**Person responsible for module:** Dean of studies
Course frequency: on an irregular basis	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4737: Special course in variational analysis	3 C 2 WLH

Learning outcome, core skills:	Workload:
Learning outcome: The successful completion of modules of the cycle "Variational analysis" enables students to learn methods, concepts, theories and applications in variational analysis and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • understand basic concepts of convex and variational analysis for finite- and infinite-dimensional problems; • master the characteristics of convexity and other concepts of the regularity of sets and functions to evaluate the existence and regularity of the solutions of variational problems; • understand basic concepts of the convergence of sets and continuity of set-valued functions; • understand basic concepts of variational geometry; • calculate and use generalised derivations (subderivatives and subgradients) of non-smooth functions; • understand the different concepts of regularity of set-valued functions and their effects on the calculation rules for subderivatives of non-convex functionals; • analyse constrained and parametric optimisation problems with the help of duality theory; • calculate and use the Legendre-Fenchel transformation and infimal convulutions; • formulate optimality criteria for continuous optimisation problems with tools of convex and variational analysis; • apply tools of convex and variational analysis to solve generalised inclusions that e. g. originate from first-order optimality criteria; • understand the connection between convex functions and monotone operators; • examine the convergence of fixed point iterations with the help of the theory of monotone operators; • deduce methods for the solution of smooth and non-smooth continuous constrained optimisation problems and analyse their convergence; • apply numerical methods for the solution of smooth and non-smooth continuous constrained programs to current problems; • model application problems with variational inequations, analyse their characteristics and are familiar with numerical methods for the solution of variational inequations; • know applications of control theory and apply methods of dynamic programming; • use tools of variational analysis in image processing and with inverse problems; • know basic concepts and methods of stochastic optimisation. **Core skills:**	Attendance time: 28 h Self-study time: 62 h

After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Variational analysis"; • become acquainted with special problems in the area "Variational analysis" to carry out scientific work for it.	

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Variational analysis"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3337
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4738: Special course in image and geometry processing**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Image and geometry processing" enables students to learn and apply methods, concepts, theories and applications in the area of "Image and geometry processing", so the digital image and geometry processing. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of problems of image and geometry processing in suitable finite- and infinite-dimensional vector spaces; • learn basic methods for the analysis of one- and multidimensional functions in Banach and Hilbert spaces; • learn basic mathematical concepts and methods that are used in image processing, like Fourier and Wavelet transform; • learn basic mathematical concepts and methods that play a central role in geometry processing, like curvature of curves and surfaces; • acquire knowledge about continuous and discrete problems of image data analysis and their corresponding solution strategies; • know basic concepts and methods of topology; • are familiar with visualisation software; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • know which special characteristics of an image or of a geometry can be extracted and worked on with which methods; • evaluate different numerical methods for the efficient analysis of multidimensional data on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear methods for the geometrical and topological analysis of multidimensional data; • are informed about current developments of efficient geometrical and topological data analysis; • adapt solution strategies for the data analysis using special structural characteristics of the given multidimensional data. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Image and geometry processing";	Attendance time: 28 h Self-study time: 62 h

• become acquainted with special problems in the area "Image and geometry processing" to carry out scientific work for it.	

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Image and geometry processing"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3338
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4739: Special course in scientific computing / applied mathematics**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Scientific computing / applied mathematics" enables students to learn and apply methods, concepts, theories and applications in the area of "Scientific computing / applied mathematics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of basic mathematical models of the corresponding subject area, especially about the existence and uniqueness of solutions; • know basic methods for the numerical solution of these models; • analyse stability, convergence and efficiency of numerical solution strategies; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • are informed about current developments of scientific computing, like e. g. GPU computing and use available soft- and hardware; • use methods of scientific computing for solving application problems, like e. g. of natural and business sciences. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Scientific computing / applied mathematics"; • become acquainted with special problems in the area "Scientific computing / applied mathematics" to carry out scientific work for it.	Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Scientific computing / applied mathematics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3339
Language: English	**Person responsible for module:** Dean of studies

Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4741: Special course in applied and mathematical stochastics**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Applied and mathematical stochastics" enables students to understand and apply a broad range of problems, theories, modelling and proof techniques of stochastics. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued: Students • are familiar with advanced concepts of probability theory established on measure theory and apply them independently; • are familiar with substantial concepts and approaches of probability modelling and inferential statistics; • know basic characteristics of stochastic processes as well as conditions for their existence and uniqueness; • have a pool of different stochastic processes in time and space at their disposal and characterise those, differentiate them and quote examples; • understand and identify basic characteristics of invariance of stochastic processes like stationary processes and isotropy; • analyse the convergence characteristic of stochastic processes; • analyse regularity characteristics of the paths of stochastic processes; • adequately model temporal and spatial phenomena in natural and economic sciences as stochastic processes, if necessary with unknown parameters; • analyse probabilistic and statistic models regarding their typical characteristics, estimate unknown parameters and make predictions for their paths on areas not observed / at times not observed; • discuss and compare different modelling approaches and evaluate the reliability of parameter estimates and predictions sceptically. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Applied and mathematical stochastics"; • become acquainted with special problems in the area "Applied and mathematical stochastics" to carry out scientific work for it.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements:	

Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Applied and mathematical stochastics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3341
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Statistics

Georg-August-Universität Göttingen **Module M.Mat.4742: Special course in stochastic processes**	3 C 2 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Stochastic processes" enables students to learn and apply methods, concepts, theories and proof techniques in the area of "Stochastic processes" and use these for the modelling of stochastic systems. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with advanced concepts of probability theory established on measure theory and apply them independently;
- know basic characteristics as well as existence and uniqueness results for stochastic processes and formulate suitable probability spaces;
- understand the relevance of the concepts of filtration, conditional expectation and stopping time for the theory of stochastic processes;
- know fundamental classes of stochastic processes (like e. g. Poisson processes, Brownian motions, Levy processes, stationary processes, multivariate and spatial processes as well as branching processes) and construct and characterise these processes;
- analyse regularity characteristics of the paths of stochastic processes;
- construct Markov chains with discrete and general state spaces in discrete and continuous time, classify their states and analyse their characteristics;
- are familiar with the theory of general Markov processes and characterise and analyse these with the use of generators, semigroups, martingale problems and Dirichlet forms;
- analyse martingales in discrete and continuous time using the corresponding martingale theory, especially using martingale equations, martingale convergence theorems, martingale stopping theorems and martingale representation theorems;
- formulate stochastic integrals as well as stochastic differential equations with the use of the Ito calculus and analyse their characteristics;
- are familiar with stochastic concepts in general state spaces as well as with the topologies, metrics and convergence theorems relevant for stochastic processes;
- know fundamental convergence theorems for stochastic processes and generalise these;
- model stochastic systems from different application areas in natural sciences and technology with the aid of suitable stochastic processes;
- analyse models in mathematical economics and finance and understand evaluation methods for financial products.

Core skills:

After having successfully completed the module, students will be able to

- conduct scholarly debates about problems of the area "Stochastic processes";

Workload:

Attendance time:
28 h

Self-study time:
62 h

• become acquainted with special problems in the area "Stochastic processes" to carry out scientific work for it.	

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Stochastic processes"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3342
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Statistics

Georg-August-Universität Göttingen **Module M.Mat.4743: Special course in stochastic methods of economathematics**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Stochastic methods of economathematics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master problems, basic concepts and stochastic methods of economathematics; • understand stochastic connections; • understand references to other mathematical areas; • get to know possible applications in theory and practice; • gain insight into the connection of mathematics and economic sciences. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Stochastic methods of economathematics"; • become acquainted with special problems in the area "Stochastic methods of economathematics" to carry out scientific work for it.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Stochastic methods of economathematics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3343
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations:

Instructor: Lecturers at the Institute of Mathematical Statistics

Georg-August-Universität Göttingen **Module M.Mat.4744: Special course in mathematical statistics**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Mathematical statistics" enables students to learn methods, concepts, theories and applications in the area of "Mathematical statistics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of mathematical statistics like estimates, testing, confidence propositions and classification and use them in simple models of mathematical statistics; • evaluate statistical methods mathematically precisely via suitable risk and loss concepts; • analyse optimality characteristics of statistical estimate methods via lower and upper bounds; • analyse the error rates of statistical testing and classification methods based on the Neyman Pearson theory; • are familiar with basic statistical distribution models that base on the theory of exponential indexed families; • know different techniques to obtain lower and upper risk bounds in these models; • are confident in modelling typical data structures of regression; • analyse practical statistical problems in a mathematically accurate way with the techniques learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of mathematical statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Mathematical statistics"; • become acquainted with special problems in the area "Mathematical statistics" to carry out scientific work for it.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Mathematical statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3344
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Statistics

Georg-August-Universität Göttingen **Module M.Mat.4745: Special course in statistical modelling and inference**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Statistical modelling and inference" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the fundamental principles of statistics and inference in parametric and non-parametric models: estimation, testing, confidence statements, prediction, model selection and validation; • are familiar with the tools of asymptotic statistical inference; • learn Bayes and frequentist approaches to data modelling and inference, as well as the interplay between both, in particular empirical Bayes methods; • are able to implement Monte Carlo statistical methods for Bayes and frequentist inference and learn their theoretical properties; • become confident in non-parametric (regression) modelling and inference for various types of the data: count, categorical, dependent, etc.; • are able to develop and mathematically evaluate complex statistical models for real data problems. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Statistical modelling and inference"; • become acquainted with special problems in the area "Statistical modelling and inference" to carry out scientific work for it.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Statistical modelling and inference"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3345
Language: English	**Person responsible for module:** Dean of studies
Course frequency:	**Duration:**

not specified	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Statistics

Georg-August-Universität Göttingen **Module M.Mat.4746: Special course in multivariate statistics**	3 C 2 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Multivariate statistics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are well acquainted with the most important methods of multivariate statistics like estimation, testing, confidence statements, prediction, linear and generalized linear models, and use them in modeling real world applications;
- can apply more specific methods of multivariate statistics such as dimension reduction by principal component analysis (PCA), factor analysis and multidimensional scaling;
- are familiar with handling non-Euclidean data such as directional or shape data using parametric and non-parametric models;
- are confident using nested descriptors for non-Euclidean data and Procrustes methods in shape analysis;
- are familiar with time dependent data, basic functional data analysis and inferential concepts such as kinematic formulae;
- analyze basic dependencies between topology/geometry of underlying spaces and asymptotic limiting distributions;
- are confident to apply resampling methods to non-Euclidean descriptors;
- are familiar with high-dimensional discrimination and classification techniques such as kernel PCA, regularization methods and support vector machines;
- have a fundamental knowledge of statistics of point processes and Bayesian methods involved;
- are familiar with concepts of large scale computational statistical techniques;
- independently become acquainted with a current topic of multivariate and non-Euclidean statistics;
- evaluate complex statistical methods and enhance them in a problem-oriented way.

Core skills:

After having successfully completed the module, students will be able to

- conduct scholarly debates about problems of the area "Multivariate statistics";
- become acquainted with special problems in the area "Multivariate statistics" to carry out scientific work for it.

Workload:

Attendance time:

28 h

Self-study time:

62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Multivariate statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3346
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Statistics

Georg-August-Universität Göttingen **Module M.Mat.4747: Special course in statistical foundations of data science**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Statistical foundations of data science" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of statistical foundations of data science like estimation, testing, confidence statements, prediction, resampling, pattern recognition and classification, and use them in modeling real world applications; • evaluate statistical methods mathematically precisely via suitable statistical risk and loss concepts; • analyse characteristics of statistical estimation methods via lower and upper information bounds; • are familiar with basic statistical distribution models that base on the theory of exponential families; • are confident in modelling real world data structures such as categorial data, multidimensional and high dimensional data, data in imaging, data with serial dependencies • analyse practical statistical problems in a mathematically accurate way with the techniques and models learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with concepts of large scale computational statistical techniques; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of statistical data science; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • conduct scholarly debates about problems of the area "Statistical foundations of data science"; • become acquainted with special problems in the area "Statistical foundations of data science" to carry out scientific work for it.	Attendance time: 28 h Self-study time: 62 h

Course: Lecture course (Lecture)	2 WLH
Examination: Oral examination (approx. 20 minutes)	3 C

Examination requirements: Proof of the acquisition of further special skills and the mastery of advanced competencies in the area "Statistical foundations of data science"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3347
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Statistics

Georg-August-Universität Göttingen Module M.Mat.4811: Seminar on analytic number theory	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Analytic number theory" enables students to learn methods, concepts, theories and applications in the area of "Analytic number theory". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • solve arithmetical problems with basic, complex-analytical, and Fourier-analytical methods; • know characteristics of the Riemann zeta function and more general L-functions, and apply them to problems of number theory; • are familiar with results and methods of prime number theory; • acquire knowledge in arithmetical and analytical theory of automorphic forms, and its application in number theory; • know basic sieving methods and apply them to the problems of number theory; • know techniques used to estimate the sum of the sum of characters and of exponentials; • analyse the distribution of rational points on suitable algebraic varieties using analytical techniques; • master computation with asymptotic formulas, asymptotic analysis, and asymptotic equipartition in number theory. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Analytic number theory" and present it in a talk; • conduct scholarly debates in a familiar context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Analytic number theory"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3311
Language:	**Person responsible for module:**

English	Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4812: Seminar on analysis of partial differential equations**	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Analysis of partial differential equations" enables students to learn methods, concepts, theories and applications in the area "Analysis of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important types of partial differential equations and know their solutions; • master the Fourier transform and other techniques of the harmonic analysis to analyse partial differential equations; • are familiar with the theory of generalised functions and the theory of function spaces and use these for solving differential partial equations; • apply the basic principles of functional analysis to the solution of partial different equations; • use different theorems of function theory for solving partial different equations; • master different asymptotic techniques to study characteristics of the solutions of partial different equations; • are paradigmatically familiar with broader application areas of linear theory of partial different equations; • are paradigmatically familiar with broader application areas of non-linear theory of partial different equations; • know the importance of partial different equations in the modelling in natural and engineering sciences; • master some advanced application areas like parts of microlocal analysis or parts of algebraic analysis. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Analysis of partial differential equations" and present it in a talk; • conduct scholarly debates in a familiar context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Analysis of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3312
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4813: Seminar on differential geometry	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Differential geometry" enables students to learn methods, concepts, theories and applications in the area "Differential geometry". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master the basic concepts of differential geometry; • develop a spatial sense using the examples of curves, surfaces and hypersurfaces; • develop an understanding of the basic concepts of differential geometry like "space" and "manifolds", "symmetry" and "Lie group", "local structures" and "curvature", "global structure" and "invariants" as well as "integrability"; • master (variably weighted and sorted depending on the current courses offered) the theory of transformation groups and symmetries as well as the analysis on manifolds, the theory of manifolds with geometric structures, complex differential geometry, gauge field theory and their applications as well as the elliptical differential equations of geometry and gauge field theory; • develop an understanding for geometrical constructs, spatial patterns and the interaction of algebraic, geometrical, analytical and topological methods; • acquire the skill to apply methods of analysis, algebra and topology for the treatment of geometrical problems; • are able to import geometrical problems to a broader mathematical and physical context. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Differential geometry" and present it in a talk; • conduct scholarly debates in a familiar context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Differential geometry"	

Admission requirements:	**Recommended previous knowledge:**

none	B.Mat.3313
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4814: Seminar on algebraic topology**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic topology" students get to know the most important classes of topological spaces as well as algebraic and analytical tools for studying these spaces and the mappings between them. The students use these tools in geometry, mathematical physics, algebra and group theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic topology uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic topology and supplement one another complementarily. The following content-related competencies are pursued. Students • know the basic concepts of set-theoretic topology and continuous mappings; • construct new topologies from given topologies; • know special classes of topological spaces and their special characteristics like CW complexes, simplicial complexes and manifolds; • apply basic concepts of category theory to topological spaces; • use concepts of functors to obtain algebraic invariants of topological spaces and mappings; • know the fundamental group and the covering theory as well as the basic methods for the computation of fundamental groups and mappings between them; • know homology and cohomology, calculate those for important examples and with the aid of these deduce non-existence of mappings as well as fixed-point theorems; • calculate homology and cohomology with the aid of chain complexes; • deduce algebraic characteristics of homology and cohomology with the aid of homological algebra; • become acquainted with connections between analysis and topology; • apply algebraic structures to deduce special global characteristics of the cohomology of a local structure of manifolds. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Algebraic topology" and present it in a talk; • conduct scholarly debates in a familiar context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes)	3 C

Examination prerequisites: Participation in the seminar	
Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Algebraic topology"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3314
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4815: Seminar on mathematical methods in physics	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Mathematical methods of physics" students get to know different mathematical methods and techniques that play a role in modern physics. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. The topics of the cycle can be divided into four blocks, a cycle normally contains parts of different blocks, that topically supplement each other, but can also be read within one block. The introducing parts of the cycle form the basis for the advanced specialisation area. The topic blocks are • harmonic analysis, algebraic structures and representation theory, (group) effects; • operator algebra, C* algebra and von-Neumann algebra; • operator theory, perturbation and scattering theory, special PDE, microlocal analysis, distributions; • (semi) Riemannian geometry, symplectic and Poisson geometry, quantization. One of the aims is that a connection to physical problems is visible, at least in the motivation of the covered topics. Preferably, in the advanced part of the cycle, the students should know and be able to carry out practical applications themselves. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Mathematical methods of physics" and present it in a talk; • conduct scholarly debates in a familiar context.	Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Mathematical methods in physics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3315
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]

Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4821: Seminar on algebraic geometry**	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic geometry" students get to know the most important classes of algebraic varieties and schemes as well as the tools for studying these objects and the mappings between them. The students apply these skills to problems of arithmetic or complex analysis. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic geometry uses and connects concepts of algebra and geometry and can be used versatilely. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic geometry and supplement one another complementarily. The following content-related competencies are pursued. Students • are familiar with commutative algebra, also in greater detail; • know the concepts of algebraic geometry, especially varieties, schemes, sheafs, bundles; • examine important examples like elliptic curves, Abelian varieties or algebraic groups; • use divisors for classification questions; • study algebraic curves; • prove the Riemann-Roch theorem and apply it; • use cohomological concepts and know the basics of Hodge theory; • apply methods of algebraic geometry to arithmetical questions and obtain e. g. finiteness principles for rational points; • classify singularities and know the significant aspects of the dimension theory of commutative algebra and algebraic geometry; • get to know connections to complex analysis and to complex geometry. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Algebraic geometry" and present it in a talk; • conduct scholarly debates in a familiar context.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C
Examination requirements:	

Autonomous permeation and presentation of complex mathematical issues in the area "Algebraic geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3321
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4822: Seminar on algebraic number theory**	3 C 2 WLH

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Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Algebraic number theory" enables students to learn methods, concepts, theories and applications in the areas "Algebraic number theory" and "Algorithmic number theory". During the course of the cycle students will be successively introduced to current theoretical and/or applied research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued in relation to algebra. Students

- know Noetherian and Dedekind rings and the class groups;
- are familiar with discriminants, differents and bifurcation theory of Hilbert;
- know geometrical number theory with applications to the unit theorem and the finiteness of class groups as well as the algorithmic aspects of lattice theory (LLL);
- are familiar with L-series and zeta functions and discuss the algebraic meaning of their residues;
- know densities, the Tchebotarew theorem and applications;
- work with orders, S-integers and S-units;
- know the class field theory of Hilbert, Takagi and Idele theoretical field theory;
- are familiar with Zp-extensions and their Iwasawa theory;
- discuss the most important hypotheses of Iwasawa theory and their consequences.

Concerning algorithmic aspects of number theory, the following competencies are pursued. Students

- work with algorithms for the identification of short lattice bases, nearest points in lattices and the shortest vectors;
- are familiar with basic algorithms of number theory in long arithmetic like GCD, fast number and polynomial arithmetic, interpolation and evaluation and prime number tests;
- use the sieving method for factorisation and calculation of discrete logarithms in finite fields of great characteristics;
- discuss algorithms for the calculation of the zeta function of elliptic curves and Abelian varieties of finite fields;
- calculate class groups and fundamental units;
- calculate Galois groups of absolute number fields.

Core skills:

After having successfully completed the module, students will be able to

- become acquainted with a mathematical topic in the area "Variational analysis" and present it in a talk;
- conduct scholarly debates in a familiar context.

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Workload:
Attendance time:
28 h
Self-study time:
62 h

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Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Algebraic number theory"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3322
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4823: Seminar on algebraic structures	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Algebraic structures" students get to know different algebraic structures, amongst others Lie algebras, Lie groups, analytical groups, associative algebras as well as the tools from algebra, geometry and category theory that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic structures use concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic structures and supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts like rings, modules, algebras and Lie algebras; • know important examples of Lie algebras and algebras; • know special classes of Lie groups and their special characteristics; • know classification theorems for finite-dimensional algebras; • apply basic concepts of category theory to algebras and modules; • know group actions and their basic classifications; • apply the enveloping algebra of Lie algebras; • apply ring and module theory to basic constructs of algebraic geometry; • use combinatorial tools for the study of associative algebras and Lie algebras; • acquire solid knowledge of the representation theory of Lie algebras, finite groups and compact Lie groups as well as the representation theory of semisimple Lie groups; • know Hopf algebras as well as their deformation and representation theory. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Algebraic structures" and present it in a talk; • conduct scholarly debates in a familiar context.	Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements:	

Autonomous permeation and presentation of complex mathematical issues in the area "Algebraic structures"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3323
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4824: Seminar on groups, geometry and dynamical systems**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Groups, geometry and dynamical systems" students get to know the most important classes of groups as well as the algebraic, geometrical and analytical tools that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Group theory uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of the area "Groups, geometry and dynamical systems" that supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts of groups and group homomorphisms; • know important examples of groups; • know special classes of groups and their special characteristics; • apply basic concepts of category theory to groups and define spaces via universal properties; • apply the concepts of functors to obtain algebraic invariants; • know group actions and their basic classification results; • know the basics of group cohomology and compute these for important examples; • know the basics of geometrical group theory like growth characteristics; • know self-similar groups, their basic constructs as well as examples with interesting characteristics; • use geometrical and combinatorial tools for the study of groups; • know the basics of the representation theory of compact Lie groups. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Groups, geometry and dynamical systems" and present it in a talk; • conduct scholarly debates in a familiar context.	Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements:	

Autonomous permeation and presentation of complex mathematical issues in the area "Groups, geometry and dynamical systems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3324
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Mat.4825: Seminar on non-commutative geometry</td><td>3 C
2 WLH</td></tr>
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Learning outcome, core skills:

Learning outcome:

In the modules of the cycle "Non-commutative geometry" students get to know the conception of space of non-commutative geometry and some of its applications in geometry, topology, mathematical physics, the theory of dynamical systems and number theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis.

Non-commutative geometry uses concepts of analysis, algebra, geometry and mathematical physics and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of non-commutative geometry that supplement one another complementarily. The following content-related competencies are pursued.

Students

- are familiar with the basic characteristics of operator algebras, especially with their representation and ideal theory;
- construct groupoids and operator algebras from different geometrical objects and apply non-commutative geometry to these domains;
- know the spectral theory of commutative C*-algebras and analyse normal operators in Hilbert spaces with it;
- know important examples of simple C*-algebras and deduce their basic characteristics;
- apply basic concepts of category theory to C*-algebras;
- model the symmetries of non-commutative spaces;
- apply Hilbert modules in C*-algebras;
- know the definition of the K-theory of C*-algebras and their formal characteristics and calculate the K-theory of C*-algebras for important examples with it;
- apply operator algebras for the formulation and analysis of index problems in geometry and for the analysis of the geometry of greater length scales;
- compare different analytical and geometrical models for the construction of mappings between K-theory groups and apply them;
- classify and analyse quantisations of manifolds via Poisson structures and know a few important methods for the construction of quantisations;
- classify W*-algebras and know the intrinsic dynamic of factors;
- apply von Neumann algebras to the axiomatic formulation of quantum field theory;
- use von Neumann algebras for the construction of L2 invariants for manifolds and groups;
- understand the connection between the analysis of C*- and W*-algebras of groups and geometrical characteristics of groups;

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Workload:

Attendance time:

28 h

Self-study time:

62 h

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• define the invariants of algebras and modules with chain complexes and their homology and calculate these; • interpret these homological invariants geometrically and correlate them with each other; • abstract new concepts from the fundamental characteristics of K-theory and other homology theories, e. g. triangulated categories. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Non-commutative geometry" and present it in a talk; • conduct scholarly debates in a familiar context.	

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Non-commutative geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3325
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4831: Seminar on inverse problems**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Inverse problems" enables students to learn methods, concepts, theories and applications in the area of "Inverse problems". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the phenomenon of illposedness and identify the degree of illposedness of typical inverse problems; • evaluate different regularisation methods for ill posed inverse problems under algorithmic aspects and with regard to various a priori information and distinguish concepts of convergence for such methods with deterministic and stochastic data errors; • analyse the convergence of regularisation methods with the help of spectral theory of bounded self-adjoint operators; • analyse the convergence of regularisation methods with the help of complex analysis; • analyse regularisation methods from stochastic error models; • apply fully data-driven models for the choice of regularisation parameters and evaluate these for concrete problems; • model identification problems in natural sciences and technology as inverse problems of partial differential equations where the unknown is e. g. a coefficient, an initial or a boundary condition or the shape of a region; • analyse the uniqueness and conditional stability of inverse problems of partial differential equations; • deduce sampling and testing methods for the solution of inverse problems of partial differential equations and analyse the convergence of such methods; • formulate mathematical models of medical imaging like computer tomography (CT) or magnetic resonance tomography (MRT) and know the basic characteristics of corresponding operators. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Inverse problems" and present it in a talk; • conduct scholarly debates in a familiar context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:**	3 C

Participation in the seminar	

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Inverse problems"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3331
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4832: Seminar on approximation methods	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Approximation methods" enables students to learn methods, concepts, theories and applications in the area of "Approximation methods", so the approximation of one- and multidimensional functions as well as for the analysis and approximation of discrete signals and images. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of approximation problems in suitable finite- and infinite-dimensional vector spaces; • can confidently handle models for the approximation of one- and multidimensional functions in Banach and Hilbert spaces; • know and use parts of classical approximation theory, e. g. Jackson and Bernstein theorems for the approximation quality for trigonometrical polynomials, approximation in translationally invariant spaces; polynomial reductions and Strang-Fix conditions; • acquire knowledge of continuous and discrete approximation problems and their corresponding solution strategies both in the one- and multidimensional case; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods for the efficient solution of the approximation problems on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear approximation methods for multidimensional data; • are informed about current developments of efficient data approximation and data analysis; • adapt solution strategies for the data approximation using special structural characteristics of the approximation problem that should be solved. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Approximation methods" and present it in a talk; • conduct scholarly debates in a familiar context.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:**	3 C

Participation in the seminar	

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Approximation methods"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3332
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4833: Seminar on numerical methods of partial differential equations**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Numerics of partial differential equations" enables students to learn methods, concepts, theories and applications in the area of "Numerics of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of linear partial differential equations, e. g. questions of classification as well as existence, uniqueness and regularity of the solution; • know the basics of the theory of linear integral equations; • are familiar with basic methods for the numerical solution of linear partial differential equations with finite difference methods (FDM), finite element methods (FEM) as well as boundary element methods (BEM); • analyse stability, consistence and convergence of FDM, FEM and BEM for linear problems; • apply methods for adaptive lattice refinement on the basis of a posteriori error approximations; • know methods for the solution of larger systems of linear equations and their preconditioners and parallelisation; • apply methods for the solution of larger systems of linear and stiff ordinary differential equations and are familiar with the problem of differential algebraic problems; • apply available software for the solution of partial differential equations and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge in the theory as well as development and application of numerical solution strategies in a special area of partial differential equations, e. g. in variation problems with constraints, singularly perturbed problems or of integral equations; • know propositions about the theory of non-linear partial differential equations of monotone and maximally monotone type as well as suitable iterative solution methods. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Numerics of partial differential equations" and present it in a talk; • conduct scholarly debates in a familiar context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Numerical methods of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3333
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4834: Seminar on optimisation**	3 C 2 WLH

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Learning outcome, core skills:
Learning outcome:

The successful completion of modules of the cycle "Optimisation" enables students to learn methods, concepts, theories and applications in the area of "Optimisation", so the discrete and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- identify optimisation problems in application-oriented problems and formulate these as mathematical programmes;
- evaluate the existence and uniqueness of the solution of an optimisation problem;
- identify structural characteristics of an optimisation problem, amongst others the existence of a finite candidate set, the structure of the underlying level set;
- know which special characteristics of the target function and the constraints (like (virtual) convexity, dc functions) for the development of solution strategies can be utilised;
- analyse the complexity of an optimisation problem;
- classify a mathematical programme in a class of optimisation problems and know current solution strategies for it;
- develop optimisation methods and adapt general methods to special problems;
- deduce upper and lower bounds for optimisation problems and understand their meaning;
- understand the geometrical structure of an optimisation problem and apply it for solution strategies;
- distinguish between proper solution methods, approximation methods with quality guarantee and heuristics and evaluate different methods on the basis of the quality of the found solutions and their computing times;
- acquire advanced knowledge in the development of solution strategies on the basis of a special area of optimisation, e. g. integer optimisation, optimisation of networks or convex optimisation;
- acquire advanced knowledge for the solution of special optimisation problems of an application-oriented area, e. g. traffic planning or location planning;
- handle advanced optimisation problems, like e. g. optimisation problems with uncertainty or multi-criteria optimisation problems.

Core skills:

After having successfully completed the module, students will be able to

- become acquainted with a mathematical topic in the area "Optimisation" and present it in a talk;
- conduct scholarly debates in a familiar context.

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Workload:
Attendance time:
28 h
Self-study time:
62 h

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Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Optimisation"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3334
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4837: Seminar on variational analysis**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Variational analysis" enables students to learn methods, concepts, theories and applications in variational analysis and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • understand basic concepts of convex and variational analysis for finite- and infinite-dimensional problems; • master the characteristics of convexity and other concepts of the regularity of sets and functions to evaluate the existence and regularity of the solutions of variational problems; • understand basic concepts of the convergence of sets and continuity of set-valued functions; • understand basic concepts of variational geometry; • calculate and use generalised derivations (subderivatives and subgradients) of non-smooth functions; • understand the different concepts of regularity of set-valued functions and their effects on the calculation rules for subderivatives of non-convex functionals; • analyse constrained and parametric optimisation problems with the help of duality theory; • calculate and use the Legendre-Fenchel transformation and infimal convulutions; • formulate optimality criteria for continuous optimisation problems with tools of convex and variational analysis; • apply tools of convex and variational analysis to solve generalised inclusions that e. g. originate from first-order optimality criteria; • understand the connection between convex functions and monotone operators; • examine the convergence of fixed point iterations with the help of the theory of monotone operators; • deduce methods for the solution of smooth and non-smooth continuous constrained optimisation problems and analyse their convergence; • apply numerical methods for the solution of smooth and non-smooth continuous constrained programs to current problems; • model application problems with variational inequations, analyse their characteristics and are familiar with numerical methods for the solution of variational inequations; • know applications of control theory and apply methods of dynamic programming; • use tools of variational analysis in image processing and with inverse problems; • know basic concepts and methods of stochastic optimisation. **Core skills:**	Attendance time: 28 h Self-study time: 62 h

After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Variational analysis" and present it in a talk; • conduct scholarly debates in a familiar context.	

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Variational analysis"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3337
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: Instructor: Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4838: Seminar on image and geometry processing	3 C 2 WLH

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Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Image and geometry processing" enables students to learn and apply methods, concepts, theories and applications in the area of "Image and geometry processing", so the digital image and geometry processing. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with the modelling of problems of image and geometry processing in suitable finite- and infinite-dimensional vector spaces;
- learn basic methods for the analysis of one- and multidimensional functions in Banach and Hilbert spaces;
- learn basic mathematical concepts and methods that are used in image processing, like Fourier and Wavelet transform;
- learn basic mathematical concepts and methods that play a central role in geometry processing, like curvature of curves and surfaces;
- acquire knowledge about continuous and discrete problems of image data analysis and their corresponding solution strategies;
- know basic concepts and methods of topology;
- are familiar with visualisation software;
- apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically;
- know which special characteristics of an image or of a geometry can be extracted and worked on with which methods;
- evaluate different numerical methods for the efficient analysis of multidimensional data on the basis of the quality of the solutions, the complexity and their computing time;
- acquire advanced knowledge about linear and non-linear methods for the geometrical and topological analysis of multidimensional data;
- are informed about current developments of efficient geometrical and topological data analysis;
- adapt solution strategies for the data analysis using special structural characteristics of the given multidimensional data.

Core skills:

After having successfully completed the module, students will be able to

- become acquainted with a mathematical topic in the area "Image and geometry processing" and present it in a talk;
- conduct scholarly debates in a familiar context.

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Workload:

Attendance time:

28 h

Self-study time:

62 h

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Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Image and geometry processing"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3338
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4839: Seminar on scientific computing / applied mathematics**	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Scientific computing / Applied mathematics" enables students to learn and apply methods, concepts, theories and applications in the area of "Scientific computing / Applied mathematics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of basic mathematical models of the corresponding subject area, especially about the existence and uniqueness of solutions; • know basic methods for the numerical solution of these models; • analyse stability, convergence and efficiency of numerical solution strategies; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • are informed about current developments of scientific computing, like e. g. GPU computing and use available soft- and hardware; • use methods of scientific computing for solving application problems, like e. g. of natural and business sciences. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Scientific computing / applied mathematics" and present it in a talk; • conduct scholarly debates in a familiar context.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C
Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Scientific computing / applied mathematics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3339
Language: English	**Person responsible for module:** Dean of studies

Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4841: Seminar on applied and mathematical stochastics**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Applied and mathematical stochastics" enables students to understand and apply a broad range of problems, theories, modelling and proof techniques of stochastics. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued: Students • are familiar with advanced concepts of probability theory established on measure theory and apply them independently; • are familiar with substantial concepts and approaches of probability modelling and inferential statistics; • know basic characteristics of stochastic processes as well as conditions for their existence and uniqueness; • have a pool of different stochastic processes in time and space at their disposal and characterise those, differentiate them and quote examples; • understand and identify basic characteristics of invariance of stochastic processes like stationary processes and isotropy; • analyse the convergence characteristic of stochastic processes; • analyse regularity characteristics of the paths of stochastic processes; • adequately model temporal and spatial phenomena in natural and economic sciences as stochastic processes, if necessary with unknown parameters; • analyse probabilistic and statistic models regarding their typical characteristics, estimate unknown parameters and make predictions for their paths on areas not observed / at times not observed; • discuss and compare different modelling approaches and evaluate the reliability of parameter estimates and predictions sceptically. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Applied and mathematical stochastics" and present it in a talk; • conduct scholarly debates in a familiar context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Applied and mathematical stochastics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3341
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4842: Seminar on stochastic processes	3 C 2 WLH

Learning outcome, core skills:	Workload:
Learning outcome: The successful completion of modules of the cycle "Stochastic processes" enables students to learn and apply methods, concepts, theories and proof techniques in the area of "Stochastic processes" and use these for the modelling of stochastic systems. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with advanced concepts of probability theory established on measure theory and apply them independently; • know basic characteristics as well as existence and uniqueness results for stochastic processes and formulate suitable probability spaces; • understand the relevance of the concepts of filtration, conditional expectation and stopping time for the theory of stochastic processes; • know fundamental classes of stochastic processes (like e. g. Poisson processes, Brownian motions, Levy processes, stationary processes, multivariate and spatial processes as well as branching processes) and construct and characterise these processes; • analyse regularity characteristics of the paths of stochastic processes; • construct Markov chains with discrete and general state spaces in discrete and continuous time, classify their states and analyse their characteristics; • are familiar with the theory of general Markov processes and characterise and analyse these with the use of generators, semigroups, martingale problems and Dirichlet forms; • analyse martingales in discrete and continuous time using the corresponding martingale theory, especially using martingale equations, martingale convergence theorems, martingale stopping theorems and martingale representation theorems; • formulate stochastic integrals as well as stochastic differential equations with the use of the Ito calculus and analyse their characteristics; • are familiar with stochastic concepts in general state spaces as well as with the topologies, metrics and convergence theorems relevant for stochastic processes; • know fundamental convergence theorems for stochastic processes and generalise these; • model stochastic systems from different application areas in natural sciences and technology with the aid of suitable stochastic processes; • analyse models in mathematical economics and finance and understand evaluation methods for financial products. **Core skills:** After having successfully completed the module, students will be able to	Attendance time: 28 h Self-study time: 62 h

• become acquainted with a mathematical topic in the area "Variational analysis" and present it in a talk; • conduct scholarly debates in a familiar context.	

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Stochastic processes"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3342
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4843: Seminar on stochastic methods of economathematics**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Stochastic methods of economathematics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master problems, basic concepts and stochastic methods of economathematics; • understand stochastic connections; • understand references to other mathematical areas; • get to know possible applications in theory and practice; • gain insight into the connection of mathematics and economic sciences. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Stochastic methods of economathematics" and present it in a talk; • conduct scholarly debates in a familiar context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Stochastic methods of economathematics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3343
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4844: Seminar on mathematical statistics	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Mathematical statistics" enables students to learn methods, concepts, theories and applications in the area of "Mathematical statistics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of mathematical statistics like estimates, testing, confidence propositions and classification and use them in simple models of mathematical statistics; • evaluate statistical methods mathematically precisely via suitable risk and loss concepts; • analyse optimality characteristics of statistical estimate methods via lower and upper bounds; • analyse the error rates of statistical testing and classification methods based on the Neyman Pearson theory; • are familiar with basic statistical distribution models that base on the theory of exponential indexed families; • know different techniques to obtain lower and upper risk bounds in these models; • are confident in modelling typical data structures of regression; • analyse practical statistical problems in a mathematically accurate way with the techniques learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of mathematical statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Mathematical statistics" and present it in a talk; • conduct scholarly debates in a familiar context.	Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:**	3 C

Participation in the seminar	

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Mathematical statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3344
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4845: Seminar on statistical modelling and inference	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Statistical modelling and inference" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the fundamental principles of statistics and inference in parametric and non-parametric models: estimation, testing, confidence statements, prediction, model selection and validation; • are familiar with the tools of asymptotic statistical inference; • learn Bayes and frequentist approaches to data modelling and inference, as well as the interplay between both, in particular empirical Bayes methods; • are able to implement Monte Carlo statistical methods for Bayes and frequentist inference and learn their theoretical properties; • become confident in non-parametric (regression) modelling and inference for various types of the data: count, categorical, dependent, etc.; • are able to develop and mathematically evaluate complex statistical models for real data problems. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Statistical modelling and inference" and present it in a talk; • conduct scholarly debates in a familiar context.	Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Statistical modelling and inference"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3345
Language: English	**Person responsible for module:** Dean of studies
Course frequency:	**Duration:**

not specified	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Mat.4846: Seminar on multivariate statistics</td><td>3 C
2 WLH</td></tr>
<tr><td>Learning outcome, core skills:
Learning outcome:
The successful completion of modules of the cycle "Multivariate statistics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students
• are well acquainted with the most important methods of multivariate statistics like estimation, testing, confidence statements, prediction, linear and generalized linear models, and use them in modeling real world applications;
• can apply more specific methods of multivariate statistics such as dimension reduction by principal component analysis (PCA), factor analysis and multidimensional scaling;
• are familiar with handling non-Euclidean data such as directional or shape data using parametric and non-parametric models;
• are confident using nested descriptors for non-Euclidean data and Procrustes methods in shape analysis;
• are familiar with time dependent data, basic functional data analysis and inferential concepts such as kinematic formulae;
• analyze basic dependencies between topology/geometry of underlying spaces and asymptotic limiting distributions;
• are confident to apply resampling methods to non-Euclidean descriptors;
• are familiar with high-dimensional discrimination and classification techniques such as kernel PCA, regularization methods and support vector machines;
• have a fundamental knowledge of statistics of point processes and Bayesian methods involved;
• are familiar with concepts of large scale computational statistical techniques;
• independently become acquainted with a current topic of multivariate and non-Euclidean statistics;
• evaluate complex statistical methods and enhance them in a problem-oriented way.
Core skills:
After having successfully completed the module, students will be able to
• become acquainted with a mathematical topic in the area "Multivariate statistics" and present it in a talk;
• conduct scholarly debates in a familiar context.</td><td>Workload:
Attendance time:
28 h
Self-study time:
62 h</td></tr>
<tr><td>Course: Seminar (Seminar)</td><td>2 WLH</td></tr>
<tr><td>Examination: Oral Presentation (approx. 75 minutes)</td><td>3 C</td></tr>
</table>

Examination prerequisites: Participation in the seminar	
Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Multivariate statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3346
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4847: Seminar on statistical foundations of data science**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Statistical foundations of data science" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of statistical foundations of data science like estimation, testing, confidence statements, prediction, resampling, pattern recognition and classification, and use them in modeling real world applications; • evaluate statistical methods mathematically precisely via suitable statistical risk and loss concepts; • analyse characteristics of statistical estimation methods via lower and upper information bounds; • are familiar with basic statistical distribution models that base on the theory of exponential families; • are confident in modelling real world data structures such as categorial data, multidimensional and high dimensional data, data in imaging, data with serial dependencies • analyse practical statistical problems in a mathematically accurate way with the techniques and models learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with concepts of large scale computational statistical techniques; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of statistical data science; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • become acquainted with a mathematical topic in the area "Statistical foundations of data science" and present it in a talk; • conduct scholarly debates in a familiar context.	Attendance time: 28 h Self-study time: 62 h

Course: Seminar (Seminar)	2 WLH

Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues in the area "Statistical foundations of data science"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3347
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4911: Advanced seminar on analytic number theory	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Analytic number theory" enables students to learn methods, concepts, theories and applications in the area of "Analytic number theory". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • solve arithmetical problems with basic, complex-analytical, and Fourier-analytical methods; • know characteristics of the Riemann zeta function and more general L-functions, and apply them to problems of number theory; • are familiar with results and methods of prime number theory; • acquire knowledge in arithmetical and analytical theory of automorphic forms, and its application in number theory; • know basic sieving methods and apply them to the problems of number theory; • know techniques used to estimate the sum of the sum of characters and of exponentials; • analyse the distribution of rational points on suitable algebraic varieties using analytical techniques; • master computation with asymptotic formulas, asymptotic analysis, and asymptotic equipartition in number theory. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Analytic number theory" in a talk; • conduct scholarly debates with reference to current research.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Analytic number theory"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4511
Language:	**Person responsible for module:**

English	Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4912: Advanced seminar on analysis of partial differential equations	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Analysis of partial differential equations" enables students to learn methods, concepts, theories and applications in the area "Analysis of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important types of partial differential equations and know their solutions; • master the Fourier transform and other techniques of the harmonic analysis to analyse partial differential equations; • are familiar with the theory of generalised functions and the theory of function spaces and use these for solving differential partial equations; • apply the basic principles of functional analysis to the solution of partial different equations; • use different theorems of function theory for solving partial different equations; • master different asymptotic techniques to study characteristics of the solutions of partial different equations; • are paradigmatically familiar with broader application areas of linear theory of partial different equations; • are paradigmatically familiar with broader application areas of non-linear theory of partial different equations; • know the importance of partial different equations in the modelling in natural and engineering sciences; • master some advanced application areas like parts of microlocal analysis or parts of algebraic analysis. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Analysis of partial differential equations" in a talk; • conduct scholarly debates with reference to current research.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Analysis of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4512
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4913: Advanced seminar on differential geometry	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Differential geometry" enables students to learn methods, concepts, theories and applications in the area "Differential geometry". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master the basic concepts of differential geometry; • develop a spatial sense using the examples of curves, surfaces and hypersurfaces; • develop an understanding of the basic concepts of differential geometry like "space" and "manifolds", "symmetry" and "Lie group", "local structures" and "curvature", "global structure" and "invariants" as well as "integrability"; • master (variably weighted and sorted depending on the current courses offered) the theory of transformation groups and symmetries as well as the analysis on manifolds, the theory of manifolds with geometric structures, complex differential geometry, gauge field theory and their applications as well as the elliptical differential equations of geometry and gauge field theory; • develop an understanding for geometrical constructs, spatial patterns and the interaction of algebraic, geometrical, analytical and topological methods; • acquire the skill to apply methods of analysis, algebra and topology for the treatment of geometrical problems; • are able to import geometrical problems to a broader mathematical and physical context. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Differential geometry" in a talk; • conduct scholarly debates with reference to current research.	Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Differential geometry"	

Admission requirements:	**Recommended previous knowledge:**

none	M.Mat.4513
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4914: Advanced seminar on algebraic topology	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic topology" students get to know the most important classes of topological spaces as well as algebraic and analytical tools for studying these spaces and the mappings between them. The students use these tools in geometry, mathematical physics, algebra and group theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic topology uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic topology and supplement one another complementarily. The following content-related competencies are pursued. Students • know the basic concepts of set-theoretic topology and continuous mappings; • construct new topologies from given topologies; • know special classes of topological spaces and their special characteristics like CW complexes, simplicial complexes and manifolds; • apply basic concepts of category theory to topological spaces; • use concepts of functors to obtain algebraic invariants of topological spaces and mappings; • know the fundamental group and the covering theory as well as the basic methods for the computation of fundamental groups and mappings between them; • know homology and cohomology, calculate those for important examples and with the aid of these deduce non-existence of mappings as well as fixed-point theorems; • calculate homology and cohomology with the aid of chain complexes; • deduce algebraic characteristics of homology and cohomology with the aid of homological algebra; • become acquainted with connections between analysis and topology; • apply algebraic structures to deduce special global characteristics of the cohomology of a local structure of manifolds. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Algebraic topology" in a talk; • conduct scholarly debates with reference to current research.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes)	3 C

Examination prerequisites: Participation in the advanced seminar	
Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Algebraic topology"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4514
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4915: Advanced seminar on mathematical methods in physics	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Mathematical methods of physics" students get to know different mathematical methods and techniques that play a role in modern physics. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. The topics of the cycle can be divided into four blocks, a cycle normally contains parts of different blocks, that topically supplement each other, but can also be read within one block. The introducing parts of the cycle form the basis for the advanced specialisation area. The topic blocks are • harmonic analysis, algebraic structures and representation theory, (group) effects; • operator algebra, C* algebra and von-Neumann algebra; • operator theory, perturbation and scattering theory, special PDE, microlocal analysis, distributions; • (semi) Riemannian geometry, symplectic and Poisson geometry, quantization. One of the aims is that a connection to physical problems is visible, at least in the motivation of the covered topics. Preferably, in the advanced part of the cycle, the students should know and be able to carry out practical applications themselves. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Mathematical methods of physics" in a talk; • conduct scholarly debates with reference to current research.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Mathematical methods in physics"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4515
Language: English	**Person responsible for module:** Dean of studies
Course frequency:	**Duration:**

not specified	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4921: Advanced seminar on algebraic geometry	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic geometry" students get to know the most important classes of algebraic varieties and schemes as well as the tools for studying these objects and the mappings between them. The students apply these skills to problems of arithmetic or complex analysis. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic geometry uses and connects concepts of algebra and geometry and can be used versatilely. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic geometry and supplement one another complementarily. The following content-related competencies are pursued. Students • are familiar with commutative algebra, also in greater detail; • know the concepts of algebraic geometry, especially varieties, schemes, sheafs, bundles; • examine important examples like elliptic curves, Abelian varieties or algebraic groups; • use divisors for classification questions; • study algebraic curves; • prove the Riemann-Roch theorem and apply it; • use cohomological concepts and know the basics of Hodge theory; • apply methods of algebraic geometry to arithmetical questions and obtain e. g. finiteness principles for rational points; • classify singularities and know the significant aspects of the dimension theory of commutative algebra and algebraic geometry; • get to know connections to complex analysis and to complex geometry. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Algebraic geometry" in a talk; • conduct scholarly debates with reference to current research.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements:	

Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Algebraic geometry"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4521
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen Module M.Mat.4922: Advanced seminar on algebraic number theory	3 C 2 WLH

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Learning outcome, core skills:
Learning outcome:

The successful completion of modules of the cycle "Algebraic number theory" enables students to learn methods, concepts, theories and applications in the areas "Algebraic number theory" and "Algorithmic number theory". During the course of the cycle students will be successively introduced to current theoretical and/or applied research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued in relation to algebra. Students

- know Noetherian and Dedekind rings and the class groups;
- are familiar with discriminants, differents and bifurcation theory of Hilbert;
- know geometrical number theory with applications to the unit theorem and the finiteness of class groups as well as the algorithmic aspects of lattice theory (LLL);
- are familiar with L-series and zeta functions and discuss the algebraic meaning of their residues;
- know densities, the Tchebotarew theorem and applications;
- work with orders, S-integers and S-units;
- know the class field theory of Hilbert, Takagi and Idele theoretical field theory;
- are familiar with Zp-extensions and their Iwasawa theory;
- discuss the most important hypotheses of Iwasawa theory and their consequences.

Concerning algorithmic aspects of number theory, the following competencies are pursued. Students

- work with algorithms for the identification of short lattice bases, nearest points in lattices and the shortest vectors;
- are familiar with basic algorithms of number theory in long arithmetic like GCD, fast number and polynomial arithmetic, interpolation and evaluation and prime number tests;
- use the sieving method for factorisation and calculation of discrete logarithms in finite fields of great characteristics;
- discuss algorithms for the calculation of the zeta function of elliptic curves and Abelian varieties of finite fields;
- calculate class groups and fundamental units;
- calculate Galois groups of absolute number fields.

Core skills:

After having successfully completed the module, students will be able to

- present a mathematical topic of current research interest in the area "Algebraic number theory" in a talk;
- conduct scholarly debates with reference to current research.

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Workload:
Attendance time:
28 h
Self-study time:
62 h

</td>
</tr>
</table>

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Algebraic number theory"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4522
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4923: Advanced seminar on algebraic structures**	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Algebraic structures" students get to know different algebraic structures, amongst others Lie algebras, Lie groups, analytical groups, associative algebras as well as the tools from algebra, geometry and category theory that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Algebraic structures use concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of algebraic structures and supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts like rings, modules, algebras and Lie algebras; • know important examples of Lie algebras and algebras; • know special classes of Lie groups and their special characteristics; • know classification theorems for finite-dimensional algebras; • apply basic concepts of category theory to algebras and modules; • know group actions and their basic classifications; • apply the enveloping algebra of Lie algebras; • apply ring and module theory to basic constructs of algebraic geometry; • use combinatorial tools for the study of associative algebras and Lie algebras; • acquire solid knowledge of the representation theory of Lie algebras, finite groups and compact Lie groups as well as the representation theory of semisimple Lie groups; • know Hopf algebras as well as their deformation and representation theory. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Algebraic structures" in a talk; • conduct scholarly debates with reference to current research.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements:	

Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Algebraic structures"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4523
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4924: Advanced seminar on groups, geometry and dynamical systems**	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** In the modules of the cycle "Groups, geometry and dynamical systems" students get to know the most important classes of groups as well as the algebraic, geometrical and analytical tools that are necessary for their study and applications. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Group theory uses concepts and tools of algebra, geometry and analysis and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of the area "Groups, geometry and dynamical systems" that supplement one another complementarily. The following content-related competencies are pursued. Students • know basic concepts of groups and group homomorphisms; • know important examples of groups; • know special classes of groups and their special characteristics; • apply basic concepts of category theory to groups and define spaces via universal properties; • apply the concepts of functors to obtain algebraic invariants; • know group actions and their basic classification results; • know the basics of group cohomology and compute these for important examples; • know the basics of geometrical group theory like growth characteristics; • know self-similar groups, their basic constructs as well as examples with interesting characteristics; • use geometrical and combinatorial tools for the study of groups; • know the basics of the representation theory of compact Lie groups. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Groups, geometry and dynamical systems" in a talk; • conduct scholarly debates with reference to current research.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C
Examination requirements:	

Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Groups, geometry and dynamical systems"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4524
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4925: Advanced seminar on non-commutative geometry**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: In the modules of the cycle "Non-commutative geometry" students get to know the conception of space of non-commutative geometry and some of its applications in geometry, topology, mathematical physics, the theory of dynamical systems and number theory. They are introduced to current research questions and enabled to carry out independent contributions to research, e. g. within the scope of a Master's thesis. Non-commutative geometry uses concepts of analysis, algebra, geometry and mathematical physics and can be applied to these areas. In the course offer several aspects are considered at a time and a cycle will only cover some of the learning objectives mentioned below. The introduction to the cycle and the specialisation in the cycle will normally cover different aspects of non-commutative geometry that supplement one another complementarily. The following content-related competencies are pursued. Students • are familiar with the basic characteristics of operator algebras, especially with their representation and ideal theory; • construct groupoids and operator algebras from different geometrical objects and apply non-commutative geometry to these domains; • know the spectral theory of commutative C*-algebras and analyse normal operators in Hilbert spaces with it; • know important examples of simple C*-algebras and deduce their basic characteristics; • apply basic concepts of category theory to C*-algebras; • model the symmetries of non-commutative spaces; • apply Hilbert modules in C*-algebras; • know the definition of the K-theory of C*-algebras and their formal characteristics and calculate the K-theory of C*-algebras for important examples with it; • apply operator algebras for the formulation and analysis of index problems in geometry and for the analysis of the geometry of greater length scales; • compare different analytical and geometrical models for the construction of mappings between K-theory groups and apply them; • classify and analyse quantisations of manifolds via Poisson structures and know a few important methods for the construction of quantisations; • classify W*-algebras and know the intrinsic dynamic of factors; • apply von Neumann algebras to the axiomatic formulation of quantum field theory; • use von Neumann algebras for the construction of L2 invariants for manifolds and groups; • understand the connection between the analysis of C*- and W*-algebras of groups and geometrical characteristics of groups; • define the invariants of algebras and modules with chain complexes and their homology and calculate these;	Attendance time: 28 h Self-study time: 62 h

• interpret these homological invariants geometrically and correlate them with each other; • abstract new concepts from the fundamental characteristics of K-theory and other homology theories, e. g. triangulated categories. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Non-commutative geometry" in a talk; • conduct scholarly debates with reference to current research.	

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Non-commutative geometry"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4525
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Mathematical Institute

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Mat.4931: Advanced seminar on inverse problems</td><td>3 C
2 WLH</td></tr>
</table>

<table>
<tr><td>Learning outcome, core skills:
Learning outcome:
The successful completion of modules of the cycle "Inverse problems" enables students to learn methods, concepts, theories and applications in the area of "Inverse problems". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students
• are familiar with the phenomenon of illposedness and identify the degree of illposedness of typical inverse problems;
• evaluate different regularisation methods for ill posed inverse problems under algorithmic aspects and with regard to various a priori information and distinguish concepts of convergence for such methods with deterministic and stochastic data errors;
• analyse the convergence of regularisation methods with the help of spectral theory of bounded self-adjoint operators;
• analyse the convergence of regularisation methods with the help of complex analysis;
• analyse regularisation methods from stochastic error models;
• apply fully data-driven models for the choice of regularisation parameters and evaluate these for concrete problems;
• model identification problems in natural sciences and technology as inverse problems of partial differential equations where the unknown is e. g. a coefficient, an initial or a boundary condition or the shape of a region;
• analyse the uniqueness and conditional stability of inverse problems of partial differential equations;
• deduce sampling and testing methods for the solution of inverse problems of partial differential equations and analyse the convergence of such methods;
• formulate mathematical models of medical imaging like computer tomography (CT) or magnetic resonance tomography (MRT) and know the basic characteristics of corresponding operators.
Core skills:
After having successfully completed the module, students will be able to
• present a mathematical topic of current research interest in the area "Inverse problems" in a talk;
• conduct scholarly debates with reference to current research.</td><td>Workload:
Attendance time:
28 h
Self-study time:
62 h</td></tr>
</table>

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Inverse problems"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4531
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4932: Advanced seminar on approximation methods**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Approximation methods" enables students to learn methods, concepts, theories and applications in the area of "Approximation methods", so the approximation of one- and multidimensional functions as well as for the analysis and approximation of discrete signals and images. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the modelling of approximation problems in suitable finite- and infinite-dimensional vector spaces; • can confidently handle models for the approximation of one- and multidimensional functions in Banach and Hilbert spaces; • know and use parts of classical approximation theory, e. g. Jackson and Bernstein theorems for the approximation quality for trigonometrical polynomials, approximation in translationally invariant spaces; polynomial reductions and Strang-Fix conditions; • acquire knowledge of continuous and discrete approximation problems and their corresponding solution strategies both in the one- and multidimensional case; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods for the efficient solution of the approximation problems on the basis of the quality of the solutions, the complexity and their computing time; • acquire advanced knowledge about linear and non-linear approximation methods for multidimensional data; • are informed about current developments of efficient data approximation and data analysis; • adapt solution strategies for the data approximation using special structural characteristics of the approximation problem that should be solved. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Approximation methods" in a talk; • conduct scholarly debates with reference to current research.	Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:**	3 C

Participation in the advanced seminar	

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Approximation methods"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4532
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Mat.4933: Advanced seminar on numerical methods of partial differential equations</td><td>3 C
2 WLH</td></tr>
</table>

<table>
<tr><td>

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Numerics of partial differential equations" enables students to learn methods, concepts, theories and applications in the area of "Numerics of partial differential equations". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with the theory of linear partial differential equations, e. g. questions of classification as well as existence, uniqueness and regularity of the solution;
- know the basics of the theory of linear integral equations;
- are familiar with basic methods for the numerical solution of linear partial differential equations with finite difference methods (FDM), finite element methods (FEM) as well as boundary element methods (BEM);
- analyse stability, consistence and convergence of FDM, FEM and BEM for linear problems;
- apply methods for adaptive lattice refinement on the basis of a posteriori error approximations;
- know methods for the solution of larger systems of linear equations and their preconditioners and parallelisation;
- apply methods for the solution of larger systems of linear and stiff ordinary differential equations and are familiar with the problem of differential algebraic problems;
- apply available software for the solution of partial differential equations and evaluate the results sceptically;
- evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time;
- acquire advanced knowledge in the theory as well as development and application of numerical solution strategies in a special area of partial differential equations, e. g. in variation problems with constraints, singularly perturbed problems or of integral equations;
- know propositions about the theory of non-linear partial differential equations of monotone and maximally monotone type as well as suitable iterative solution methods.

Core skills:

After having successfully completed the module, students will be able to

- present a mathematical topic of current research interest in the area "Numerics of partial differential equations" in a talk;
- conduct scholarly debates with reference to current research.

</td><td>

Workload:

Attendance time:
28 h
Self-study time:
62 h

</td></tr>
</table>

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C
Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Numerical methods of partial differential equations"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4533
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4934: Advanced seminar on optimisation**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Optimisation" enables students to learn methods, concepts, theories and applications in the area of "Optimisation", so the discrete and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • identify optimisation problems in application-oriented problems and formulate these as mathematical programmes; • evaluate the existence and uniqueness of the solution of an optimisation problem; • identify structural characteristics of an optimisation problem, amongst others the existence of a finite candidate set, the structure of the underlying level set; • know which special characteristics of the target function and the constraints (like (virtual) convexity, dc functions) for the development of solution strategies can be utilised; • analyse the complexity of an optimisation problem; • classify a mathematical programme in a class of optimisation problems and know current solution strategies for it; • develop optimisation methods and adapt general methods to special problems; • deduce upper and lower bounds for optimisation problems and understand their meaning; • understand the geometrical structure of an optimisation problem and apply it for solution strategies; • distinguish between proper solution methods, approximation methods with quality guarantee and heuristics and evaluate different methods on the basis of the quality of the found solutions and their computing times; • acquire advanced knowledge in the development of solution strategies on the basis of a special area of optimisation, e. g. integer optimisation, optimisation of networks or convex optimisation; • acquire advanced knowledge for the solution of special optimisation problems of an application-oriented area, e. g. traffic planning or location planning; • handle advanced optimisation problems, like e. g. optimisation problems with uncertainty or multi-criteria optimisation problems. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Optimisation" in a talk; • conduct scholarly debates with reference to current research.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Optimisation"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4534
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Mat.4937: Advanced seminar on variational analysis</td><td>3 C
2 WLH</td></tr>
</table>

Learning outcome, core skills:	Workload:
Learning outcome: The successful completion of modules of the cycle "Variational analysis" enables students to learn methods, concepts, theories and applications in variational analysis and continuous optimisation. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • understand basic concepts of convex and variational analysis for finite- and infinite-dimensional problems; • master the characteristics of convexity and other concepts of the regularity of sets and functions to evaluate the existence and regularity of the solutions of variational problems; • understand basic concepts of the convergence of sets and continuity of set-valued functions; • understand basic concepts of variational geometry; • calculate and use generalised derivations (subderivatives and subgradients) of non-smooth functions; • understand the different concepts of regularity of set-valued functions and their effects on the calculation rules for subderivatives of non-convex functionals; • analyse constrained and parametric optimisation problems with the help of duality theory; • calculate and use the Legendre-Fenchel transformation and infimal convulutions; • formulate optimality criteria for continuous optimisation problems with tools of convex and variational analysis; • apply tools of convex and variational analysis to solve generalised inclusions that e. g. originate from first-order optimality criteria; • understand the connection between convex functions and monotone operators; • examine the convergence of fixed point iterations with the help of the theory of monotone operators; • deduce methods for the solution of smooth and non-smooth continuous constrained optimisation problems and analyse their convergence; • apply numerical methods for the solution of smooth and non-smooth continuous constrained programs to current problems; • model application problems with variational inequations, analyse their characteristics and are familiar with numerical methods for the solution of variational inequations; • know applications of control theory and apply methods of dynamic programming; • use tools of variational analysis in image processing and with inverse problems; • know basic concepts and methods of stochastic optimisation. **Core skills:**	Attendance time: 28 h Self-study time: 62 h

After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Variational analysis" in a talk; • conduct scholarly debates with reference to current research.	

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Variational analysis"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4537
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: Instructor: Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen Module M.Mat.4938: Advanced seminar on image and geometry processing	3 C 2 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Image and geometry processing" enables students to learn and apply methods, concepts, theories and applications in the area of "Image and geometry processing", so the digital image and geometry processing. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with the modelling of problems of image and geometry processing in suitable finite- and infinite-dimensional vector spaces;
- learn basic methods for the analysis of one- and multidimensional functions in Banach and Hilbert spaces;
- learn basic mathematical concepts and methods that are used in image processing, like Fourier and Wavelet transform;
- learn basic mathematical concepts and methods that play a central role in geometry processing, like curvature of curves and surfaces;
- acquire knowledge about continuous and discrete problems of image data analysis and their corresponding solution strategies;
- know basic concepts and methods of topology;
- are familiar with visualisation software;
- apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically;
- know which special characteristics of an image or of a geometry can be extracted and worked on with which methods;
- evaluate different numerical methods for the efficient analysis of multidimensional data on the basis of the quality of the solutions, the complexity and their computing time;
- acquire advanced knowledge about linear and non-linear methods for the geometrical and topological analysis of multidimensional data;
- are informed about current developments of efficient geometrical and topological data analysis;
- adapt solution strategies for the data analysis using special structural characteristics of the given multidimensional data.

Core skills:

After having successfully completed the module, students will be able to

- present a mathematical topic of current research interest in the area "Image and geometry processing" in a talk;
- conduct scholarly debates with reference to current research.

Workload:

Attendance time:
28 h

Self-study time:
62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C
Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Image and geometry processing"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4538
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4939: Advanced seminar on scientific computing / applied mathematics**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Scientific computing / applied mathematics" enables students to learn and apply methods, concepts, theories and applications in the area of "Scientific computing / applied mathematics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a practical course in scientific computing or a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the theory of basic mathematical models of the corresponding subject area, especially about the existence and uniqueness of solutions; • know basic methods for the numerical solution of these models; • analyse stability, convergence and efficiency of numerical solution strategies; • apply available software for the solution of the corresponding numerical methods and evaluate the results sceptically; • evaluate different numerical methods on the basis of the quality of the solutions, the complexity and their computing time; • are informed about current developments of scientific computing, like e. g. GPU computing and use available soft- and hardware; • use methods of scientific computing for solving application problems, like e. g. of natural and business sciences. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Scientific computing / applied mathematics" in a talk; • conduct scholarly debates with reference to current research.	Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements:	
Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Scientific computing / applied mathematics"	

Admission requirements:	**Recommended previous knowledge:**
none	M.Mat.4539
Language:	**Person responsible for module:**

English	Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Mat.4941: Advanced seminar on applied and mathematical stochastics</td><td>3 C
2 WLH</td></tr>
</table>

<table>
<tr><td>
Learning outcome, core skills:
Learning outcome:
The successful completion of modules of the cycle "Applied and mathematical stochastics" enables students to understand and apply a broad range of problems, theories, modelling and proof techniques of stochastics. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued: Students

are familiar with advanced concepts of probability theory established on measure theory and apply them independently;
are familiar with substantial concepts and approaches of probability modelling and inferential statistics;
know basic characteristics of stochastic processes as well as conditions for their existence and uniqueness;
have a pool of different stochastic processes in time and space at their disposal and characterise those, differentiate them and quote examples;
understand and identify basic characteristics of invariance of stochastic processes like stationary processes and isotropy;
analyse the convergence characteristic of stochastic processes;
analyse regularity characteristics of the paths of stochastic processes;
adequately model temporal and spatial phenomena in natural and economic sciences as stochastic processes, if necessary with unknown parameters;
analyse probabilistic and statistic models regarding their typical characteristics, estimate unknown parameters and make predictions for their paths on areas not observed / at times not observed;
discuss and compare different modelling approaches and evaluate the reliability of parameter estimates and predictions sceptically.

Core skills:
After having successfully completed the module, students will be able to

present a mathematical topic of current research interest in the area "Applied and mathematical stochastics" in a talk;
conduct scholarly debates with reference to current research.

</td><td>Workload:
Attendance time:
28 h
Self-study time:
62 h</td></tr>
</table>

<table>
<tr><td>Course: Advanced seminar</td><td>2 WLH</td></tr>
<tr><td>Examination: Oral Presentation (approx. 75 minutes)
Examination prerequisites:
Participation in the advanced seminar</td><td>3 C</td></tr>
</table>

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Applied and mathematical stochastics"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4541
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Numerical and Applied Mathematics

Georg-August-Universität Göttingen **Module M.Mat.4942: Advanced seminar on stochastic processes**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Stochastic processes" enables students to learn and apply methods, concepts, theories and proof techniques in the area of "Stochastic processes" and use these for the modelling of stochastic systems. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with advanced concepts of probability theory established on measure theory and apply them independently; • know basic characteristics as well as existence and uniqueness results for stochastic processes and formulate suitable probability spaces; • understand the relevance of the concepts of filtration, conditional expectation and stopping time for the theory of stochastic processes; • know fundamental classes of stochastic processes (like e. g. Poisson processes, Brownian motions, Levy processes, stationary processes, multivariate and spatial processes as well as branching processes) and construct and characterise these processes; • analyse regularity characteristics of the paths of stochastic processes; • construct Markov chains with discrete and general state spaces in discrete and continuous time, classify their states and analyse their characteristics; • are familiar with the theory of general Markov processes and characterise and analyse these with the use of generators, semigroups, martingale problems and Dirichlet forms; • analyse martingales in discrete and continuous time using the corresponding martingale theory, especially using martingale equations, martingale convergence theorems, martingale stopping theorems and martingale representation theorems; • formulate stochastic integrals as well as stochastic differential equations with the use of the Ito calculus and analyse their characteristics; • are familiar with stochastic concepts in general state spaces as well as with the topologies, metrics and convergence theorems relevant for stochastic processes; • know fundamental convergence theorems for stochastic processes and generalise these; • model stochastic systems from different application areas in natural sciences and technology with the aid of suitable stochastic processes; • analyse models in mathematical economics and finance and understand evaluation methods for financial products. **Core skills:** After having successfully completed the module, students will be able to	Attendance time: 28 h Self-study time: 62 h

• present a mathematical topic of current research interest in the area "Stochastic processes" in a talk; • conduct scholarly debates with reference to current research.	

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Stochastic processes"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4542
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4943: Advanced seminar on stochastic methods in economathematics	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: The successful completion of modules of the cycle "Stochastic methods of economathematics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • master problems, basic concepts and stochastic methods of economathematics; • understand stochastic connections; • understand references to other mathematical areas; • get to know possible applications in theory and practice; • gain insight into the connection of mathematics and economic sciences. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Stochastic methods in economathematics" in a talk; • conduct scholarly debates with reference to current research.	Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Stochastic methods in economathematics"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4543
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4944: Advanced seminar on mathematical statistics	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Mathematical statistics" enables students to learn methods, concepts, theories and applications in the area of "Mathematical statistics". During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Bachelor's or Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the most important methods of mathematical statistics like estimates, testing, confidence propositions and classification and use them in simple models of mathematical statistics; • evaluate statistical methods mathematically precisely via suitable risk and loss concepts; • analyse optimality characteristics of statistical estimate methods via lower and upper bounds; • analyse the error rates of statistical testing and classification methods based on the Neyman Pearson theory; • are familiar with basic statistical distribution models that base on the theory of exponential indexed families; • know different techniques to obtain lower and upper risk bounds in these models; • are confident in modelling typical data structures of regression; • analyse practical statistical problems in a mathematically accurate way with the techniques learned on the one hand and via computer simulations on the other hand; • are able to mathematically analyse resampling methods and apply them purposively; • are familiar with advanced tools of non-parametric statistics and empirical process theory; • independently become acquainted with a current topic of mathematical statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Mathematical statistics" in a talk; • conduct scholarly debates with reference to current research.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes)	3 C

Examination prerequisites: Participation in the advanced seminar	

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Mathematical statistics"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4544
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4945: Advanced seminar on statistical modelling and inference**	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Statistical modelling and inference" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are familiar with the fundamental principles of statistics and inference in parametric and non-parametric models: estimation, testing, confidence statements, prediction, model selection and validation; • are familiar with the tools of asymptotic statistical inference; • learn Bayes and frequentist approaches to data modelling and inference, as well as the interplay between both, in particular empirical Bayes methods; • are able to implement Monte Carlo statistical methods for Bayes and frequentist inference and learn their theoretical properties; • become confident in non-parametric (regression) modelling and inference for various types of the data: count, categorical, dependent, etc.; • are able to develop and mathematically evaluate complex statistical models for real data problems. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Statistical modelling and inference" in a talk; • conduct scholarly debates with reference to current research.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C
Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Statistical modelling and inference"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4545
Language: English	**Person responsible for module:** Dean of studies

Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen Module M.Mat.4946: Advanced seminar on multivariate statistics	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** The successful completion of modules of the cycle "Multivariate statistics" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students • are well acquainted with the most important methods of multivariate statistics like estimation, testing, confidence statements, prediction, linear and generalized linear models, and use them in modeling real world applications; • can apply more specific methods of multivariate statistics such as dimension reduction by principal component analysis (PCA), factor analysis and multidimensional scaling; • are familiar with handling non-Euclidean data such as directional or shape data using parametric and non-parametric models; • are confident using nested descriptors for non-Euclidean data and Procrustes methods in shape analysis; • are familiar with time dependent data, basic functional data analysis and inferential concepts such as kinematic formulae; • analyze basic dependencies between topology/geometry of underlying spaces and asymptotic limiting distributions; • are confident to apply resampling methods to non-Euclidean descriptors; • are familiar with high-dimensional discrimination and classification techniques such as kernel PCA, regularization methods and support vector machines; • have a fundamental knowledge of statistics of point processes and Bayesian methods involved; • are familiar with concepts of large scale computational statistical techniques; • independently become acquainted with a current topic of multivariate and non-Euclidean statistics; • evaluate complex statistical methods and enhance them in a problem-oriented way. **Core skills:** After having successfully completed the module, students will be able to • present a mathematical topic of current research interest in the area "Multivariate statistics" in a talk; • conduct scholarly debates with reference to current research.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced seminar	2 WLH
Examination: Oral Presentation (approx. 75 minutes)	3 C

Examination prerequisites: Participation in the advanced seminar	
Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Multivariate statistics"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4546
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4947: Advanced seminar on statistical foundations of data science**	3 C 2 WLH

Learning outcome, core skills:

Learning outcome:

The successful completion of modules of the cycle "Statistical foundations of data science" enables students to learn methods, concepts, theories and applications in this area. During the course of the cycle students will be successively introduced to current research topics and able to carry out independent contributions to research (e. g. within the scope of a Master's thesis). Depending on the current course offer the following content-related competencies may be pursued. Students

- are familiar with the most important methods of statistical foundations of data science like estimation, testing, confidence statements, prediction, resampling, pattern recognition and classification, and use them in modeling real world applications;
- evaluate statistical methods mathematically precisely via suitable statistical risk and loss concepts;
- analyse characteristics of statistical estimation methods via lower and upper information bounds;
- are familiar with basic statistical distribution models that base on the theory of exponential families;
- are confident in modelling real world data structures such as categorial data, multidimensional and high dimensional data, data in imaging, data with serial dependencies
- analyse practical statistical problems in a mathematically accurate way with the techniques and models learned on the one hand and via computer simulations on the other hand;
- are able to mathematically analyse resampling methods and apply them purposively;
- are familiar with concepts of large scale computational statistical techniques;
- are familiar with advanced tools of non-parametric statistics and empirical process theory;
- independently become acquainted with a current topic of statistical data science;
- evaluate complex statistical methods and enhance them in a problem-oriented way.

Core skills:

After having successfully completed the module, students will be able to

- present a mathematical topic of current research interest in the area "Statistical foundations of data science" in a talk;
- conduct scholarly debates with reference to current research.

Workload:

Attendance time:
28 h

Self-study time:
62 h

Course: Advanced seminar	2 WLH

Examination: Oral Presentation (approx. 75 minutes) **Examination prerequisites:** Participation in the advanced seminar	3 C

Examination requirements: Autonomous permeation and presentation of complex mathematical issues of current research literature in the area "Statistical foundations of data science"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4547
Language: English	**Person responsible for module:** Dean of studies
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 4
Maximum number of students: not limited	

Additional notes and regulations: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Modul M.Phi.101: Ausgewählte Themen der Theoretischen Philosophie** *English title: Selected Topics in Theoretical Philosophy*	9 C 4 SWS
Lernziele/Kompetenzen: Das Wahlpflichtmodul dient der Erweiterung der Kenntnisse und Fähigkeiten in einem Wahlbereich der Philosophie. Im 42-C-Master-Fach wird hier ein Schwerpunkt mit vertieften Kenntnissen ausgebildet. Im 78-C-Master-Fach sollen ergänzende Themen studiert werden, die nicht im Bereich des zu wählenden Studienschwerpunktes (s. Module 104-107) liegen. Die Studierenden besitzen vermehrte Kenntnis von Theorieansätzen und umfassendere Problemperspektiven auf Gebieten der Theoretischen Philosophie. Sie kennen unterschiedliche Methoden und Terminologien, können Positionen und Problemstellungen in größere Zusammenhänge einordnen, mit anderen Positionen vergleichen und ihre Relevanz und Leistungsfähigkeit beurteilen. Z.B. können erkenntnistheoretische Ansätze durch zusätzliche Kenntnisse aus der Sprachphilosophie, der Ontologie oder der Philosophie des Geistes adäquater eingeschätzt werden und umgekehrt.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 214 Stunden
Lehrveranstaltung: Vorlesung für Fortgeschrittene (= nicht Einführungskurs), Seminar oder Hauptseminar zu einem Thema der theoretischen Philosophie	2 SWS
Lehrveranstaltung: Seminar oder Hauptseminar zu einem Thema der theoretischen Philosophie	2 SWS
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsvorleistungen:** Eine kleine Leistung mindestens in Textform (max. 3 Seiten) **Prüfungsanforderungen:** Kenntnisse wichtiger Positionen der Sprachphilosophie, Erkenntnistheorie, Philosophie des Geistes, Wissenschaftsphilosophie oder Metaphysik; Fähigkeit, philosophische Probleme in diesen Bereichen zu behandeln und Lösungsvorschläge unter sachgerechter Abwägung von Argumenten zu diskutieren.	7 C
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsvorleistungen:** Eine kleine Leistung mindestens in Textform (max. 3 Seiten) **Prüfungsanforderungen:** Kenntnisse wichtiger Positionen der Sprachphilosophie, Erkenntnistheorie, Philosophie des Geistes, Wissenschaftsphilosophie oder Metaphysik; Fähigkeit, philosophische Probleme in diesen Bereichen zu behandeln und Lösungsvorschläge unter sachgerechter Abwägung von Argumenten zu diskutieren.	7 C
Die folgende Prüfung ist erfolgreich zu absolvieren:	
Prüfung: Eine kleine Leistung mindestens in Textform (max. 3 Seiten), unbenotet	2 C

Prüfungsanforderungen: Fähigkeit, sich mit wichtigen Positionen der Sprachphilosophie, Erkenntnistheorie, Philosophie des Geistes, Wissenschaftsphilosophie oder Metaphysik auseinanderzusetzen und in kurzer schriftlicher Form einzelne Fragen, Probleme oder Lösungsvorschläge argumentativ verständlich darzulegen. Bei der kleinen Leistung kann es sich um ein Protokoll, ein Handout zu einem Referat, die Bearbeitung von Aufgaben oder Fragen zur Textvor- oder Nachbereitung, einen kurzen Essay oder Vergleichbares (je nach Arbeitsform der betreffenden Veranstaltung) handeln.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Misselhorn
Angebotshäufigkeit: jedes Semester	**Dauer:** 1-2 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 3
Maximale Studierendenzahl: 25	

Bemerkungen:

Von den zwei Lehrveranstaltungen darf nur eine in Form einer Vorlesung besucht werden, die andere muss ein Seminar oder Hauptseminar sein.

Es kann gewählt werden, in welcher Veranstaltung die "große" Prüfung und in welcher die kleine Leistung abgelegt wird.

Georg-August-Universität Göttingen **Modul M.Phi.102: Ausgewählte Themen der Praktischen Philosophie** *English title: Selected Topics in Practical Philosophy*	9 C 4 SWS
Lernziele/Kompetenzen: Das Wahlpflichtmodul dient der Erweiterung der Kenntnisse und Fähigkeiten in einem Wahlbereich der Philosophie. Im 42-C-Master-Fach wird hier ein Schwerpunkt mit vertieften Kenntnissen ausgebildet. Im 78-C-Master-Fach sollen ergänzende Themen studiert werden, die nicht im Bereich des zu wählenden Studienschwerpunktes (s. Module 104-107) liegen. Die Studierenden besitzen erweiterte Kenntnisse von Theorieansätzen in mehreren Bereichen der Praktischen Philosophie. Sie können ethische und politiktheoretische Positionen und Problemstellungen in größere Zusammenhänge einordnen, unterschiedliche Ansätze vergleichen und ihre Relevanz und Leistungsfähigkeit beurteilen. Im Bereich der Ethik wird z.B. die Kenntnis individualethischer Positionen durch solche der Sozialethik oder der politischen Philosophie ergänzt, durch Ansätze der Metaethik in der Grundlagendimension vertieft oder durch Ansätze der Angewandten Ethik in der Anwendungsdimension konkretisiert.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 214 Stunden
Lehrveranstaltung: Vorlesung für Fortgeschrittene (= nicht Einführungskurs), Seminar oder Hauptseminar zu einem Thema der praktischen Philosophie	2 SWS
Lehrveranstaltung: Seminar oder Hauptseminar zu einem Thema der praktischen Philosophie	2 SWS
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsvorleistungen:** Eine kleine Leistung mindestens in Textform (max. 3 Seiten) **Prüfungsanforderungen:** Kenntnisse wichtiger Positionen der Theoretischen oder der Angewandten Ethik oder der Politischen Philosophie; Fähigkeit, philosophische Probleme in diesen Bereichen zu behandeln und Lösungsvorschläge unter sachgerechter Abwägung von Argumenten zu diskutieren.	7 C
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsvorleistungen:** Eine kleine Leistung mindestens in Textform (max. 3 Seiten) **Prüfungsanforderungen:** Kenntnisse wichtiger Positionen der Theoretischen oder der Angewandten Ethik oder der Politischen Philosophie; Fähigkeit, philosophische Probleme in diesen Bereichen zu behandeln und Lösungsvorschläge unter sachgerechter Abwägung von Argumenten zu diskutieren.	7 C
Die folgende Prüfung ist erfolgreich zu absolvieren:	
Prüfung: Eine kleine Leistung mindestens in Textform (max. 3 Seiten), unbenotet **Prüfungsanforderungen:**	2 C

Fähigkeit, sich mit wichtigen Positionen der Theoretischen Ethik, der Angewandten Ethik oder der Politischen Philosophie auseinanderzusetzen und in kurzer schriftlicher Form einzelne Fragen, Probleme oder Lösungsvorschläge argumentativ verständlich darzulegen. Bei der kleinen Leistung kann es sich um ein Protokoll, ein Handout zu einem Referat, die Bearbeitung von Aufgaben oder Fragen zur Textvor- oder Nachbereitung, einen kurzen Essay oder Vergleichbares (je nach Arbeitsform der betreffenden Veranstaltung) handeln.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Holmer Steinfath
Angebotshäufigkeit: jedes Semester	**Dauer:** 1-2 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 3
Maximale Studierendenzahl: 25	

Bemerkungen:

Von den zwei Lehrveranstaltungen darf nur eine in Form einer Vorlesung besucht werden, die andere muss ein Seminar oder Hauptseminar sein.

Es kann gewählt werden, in welcher Veranstaltung die "große" Prüfung und in welcher die kleine Leistung abgelegt wird.

Georg-August-Universität Göttingen **Modul M.Phi.103: Ausgewählte Themen der Geschichte der Philosophie** *English title: Selected Topics in History of Philosophy*	9 C 4 SWS
Lernziele/Kompetenzen: Das Wahlpflichtmodul dient der Erweiterung der Kenntnisse und Fähigkeiten in einem Wahlbereich der Philosophie. Im 42-C-Master-Fach wird hier ein Schwerpunktbereich mit vertieften Kenntnissen ausgebildet. Im 78-C-Master-Fach sollen ergänzende Themen studiert werden, die nicht im Bereich des zu wählenden Studienschwerpunktes (s. Module 104-107) liegen. Die Studierenden kennen verschiedene philosophiegeschichtliche Theorieansätze und die wesentlichen Diskussionszusammenhänge, in denen sie stehen. Klassische Primärtexte können unter Einbeziehung ihrer historischen und systematischen Kontexte sachgemäß interpretiert und analysiert werden. Philosophische Positionen können entwicklungsgeschichtlich aufeinander bezogen, fortschrittliche und wiederkehrende Elemente darin erkannt und Diskussionsbeiträge oder Theorieentwürfe nach ihrer theoriegeschichtlichen Bedeutung eingeschätzt werden.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 214 Stunden
Lehrveranstaltung: Vorlesung für Fortgeschrittene (= nicht Einführungskurs), Seminar oder Hauptseminar zu einem Thema der Geschichte der Philosophie	2 SWS
Lehrveranstaltung: Seminar oder Hauptseminar zu einem Thema der Geschichte der Philosophie	2 SWS
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsvorleistungen:** Eine kleine Leistung mindestens in Textform (max. 3 Seiten) **Prüfungsanforderungen:** Kenntnisse wichtiger philosophiegeschichtlicher Werke und Positionen; Fähigkeit, klassische Texte sachgemäß zu interpretieren, in ihre historischen und systematischen Kontexte einzuordnen und ihre theoretische Leistungsfähigkeit zu beurteilen.	7 C
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsvorleistungen:** Eine kleine Leistung mindestens in Textform (max. 3 Seiten) **Prüfungsanforderungen:** Kenntnisse wichtiger philosophiegeschichtlicher Werke und Positionen; Fähigkeit, klassische Texte sachgemäß zu interpretieren, in ihre historischen und systematischen Kontexte einzuordnen und ihre theoretische Leistungsfähigkeit zu beurteilen.	7 C
Die folgende Prüfung ist erfolgreich zu absolvieren:	
Prüfung: Eine kleine Leistung mindestens in Textform (max. 3 Seiten), unbenotet **Prüfungsanforderungen:** Fähigkeit, sich mit wichtigen philosophiegeschichtlichen Werken und Positionen auseinanderzusetzen, sie sachgemäß zu interpretieren sowie in ihren historischen und	2 C

systematischen Kontexten einzuordnen. Fähigkeit, in kurzer schriftlicher Form einzelne Fragen, Probleme oder Lösungsvorschläge argumentativ verständlich darzulegen. Bei der kleinen Leistung kann es sich um ein Protokoll, ein Handout zu einem Referat, die Bearbeitung von Aufgaben oder Fragen zur Textvor- oder Nachbereitung, einen kurzen Essay oder Vergleichbares (je nach Arbeitsform der betreffenden Veranstaltung) handeln.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Sebastian Bender
Angebotshäufigkeit: jedes Semester	**Dauer:** 1-2 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 3
Maximale Studierendenzahl: 25	

Bemerkungen: Von den zwei Lehrveranstaltungen darf nur eine in Form einer Vorlesung besucht werden, die andere muss ein Seminar oder Hauptseminar sein. Es kann gewählt werden, in welcher Veranstaltung die "große" Prüfung und in welcher die kleine Leistung abgelegt wird.

Georg-August-Universität Göttingen **Module M.Phy.5601: Seminar Computational Neuroscience/Neuro-informatics**	4 C 2 WLH
Learning outcome, core skills: After successful completion of the module, students ... • have deepened their knowledge of computational neuroscience / neuroinformatics by an independent elaboration of a topic; • have learned methods of presentation of topics from computer science; • are able to deal with (English-language) literature; • are able to present an informatic topic; • are able to lead a scientific discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar (Seminar) *Course frequency:* each semester	
Examination: Presentation (approx. 45 Min.) with written report (max. 7 S.) **Examination prerequisites:** regular participation **Examination requirements:** Independent preparation and presentation of research-related topics from the area of computational neuroscience / neuroinformatics as well as biophysics of neuronal systems.	4 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5614
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: 14	

Georg-August-Universität Göttingen **Modul M.WIWI-BWL.0001: Sustainable Finance** *English title: Sustainable Finance*	6 C 4 SWS
Lernziele/Kompetenzen: Mit dem erfolgreichen Abschluss des Moduls haben die Studierenden folgende Kompetenzen erworben: • sie sind in der Lage einen fundierten Überblick über das Gebiet der Sustainable Finance zu geben und aufzuzeigen, wo Parallelen und Unterschiede zur klassischen Finanzwirtschaft bestehen, • sie können theoriebasierte Argumente für und wider eine explizite Berücksichtigung von Nachhaltigkeit als Unternehmensziel verstehen und kritisch reflektieren, • sie können Ansätze zur Integration von Nachhaltigkeit in die Portfolioselektion verstehen, kritisch reflektieren und anwenden, • sie können um den Aspekt der Nachhaltigkeit erweiterte Modell zur Marktbewertung von Wertpapieren verstehen, kritisch reflektieren und anwenden sowie deren Fähigkeit zur Erklärung empirischer Phänomene beurteilen, • sie verstehen Instrumente der nachhaltigen Fremdfinanzierung hinsichtlich ihrer Einsatzmöglichkeiten und können diese im Kontext von asymmetrischer Information und Anreizwirkungen analysieren, • sie sind in der Lage Theorien zur Integration von Nachhaltigkeit in Kapitalstrukturentscheidungen hinsichtlich ihrer praktischen Implikationen und ihrer Fähigkeit zur Erklärung empirischer Phänomene zu beurteilen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Sustainable Finance (Vorlesung) *Inhalte*: • Grundlagen: Was ist Sustainable Finance? • Nachhaltigkeit als Unternehmensziel? • Integration von Nachhaltigkeit in die Portfolioselektion. • Integration von Nachhaltigkeit ins Asset Pricing. • Nachhaltige Fremdfinanzierung. • Nachhaltigkeit und Kapitalstrukturentscheidungen.	2 SWS
Lehrveranstaltung: Sustainable Finance (Übung) *Inhalte*: Im Rahmen der begleitenden Übung vertiefen und erweitern die Studierenden die in der Vorlesung erworbenen Kenntnisse und Fähigkeiten	2 SWS
Prüfung: Klausur (60 Minuten)	6 C
Prüfungsanforderungen: • Darlegung eines übergreifenden Verständnisses des Feldes der Sustainable Finance, • Nachweis der Fähigkeit, im Rahmen theoretischer Überlegungen sinnvolle Argumentationen für und gegen die Berücksichtigung von Nachhaltigkeit als Unternehmensziel aufzubauen,	

• Fähigkeit zur Beurteilung wichtiger finanzwirtschaftlicher Konzepte wie Kapitalwert und Shareholder Value im Kontext von Nachhaltigkeit, • Nachweis des Verständnisses verschiedener Ansätze zur Integration von Nachhaltigkeit in die Portfoliosektion, • Nachweis des Verständnisses verschiedener Modelle zur Integration von Nachhaltigkeit ins Asset Pricing, • Fähigkeit zur Analyse von Instrumenten der nachhaltigen Fremdfinanzierung, • Nachweis des Verständnisses des Zusammenhangs zwischen Kapitalstrukturentscheidungen und Nachhaltigkeit.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundkenntnisse aus finanzwirtschaftlichen Veranstaltungen im Bachelorstudium
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Olaf Korn
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 2
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul M.WIWI-BWL.0002: Rechnungslegung nach IFRS** *English title: IFRS Financial Reporting*	6 C 4 SWS
Lernziele/Kompetenzen: Gegenstand der Veranstaltung sind die Ziele, Instrumente, Prinzipien und Einzelregelungen der Rechnungslegung nach den International Financial Reporting Standards (IFRS). Mit erfolgreicher Teilnahme am Moduls sind die Studierenden in der Lage die kennengelernten Regelungen einzuordnen, kritisch zu Hinterfragen und anzuwenden. Darüber hinaus können die Teilnehmer unterschiedliche Sachverhalte in Bilanzierungs- und Offenlegungsregelungen einordnen, diese kritisch würdigen und prinzipienorientierte Lösungen entwickeln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Rechnungslegung nach IFRS (Vorlesung) *Inhalte*: I. Die „IFRS-Revolution“ II. Das Konzept der kapitalmarktorientierten Rechnungslegung III. Institutionelle Grundlagen IV. Rechnungslegungsprinzipien in den IFRS V. Bestandteile des Jahresabschlusses nach IFRS VI. Ansatz und Bewertung nach den IFRS	2 SWS
Lehrveranstaltung: Rechnungslegung nach IFRS (Übung) *Inhalte*: Im Rahmen der begleitenden Übung vertiefen und erweitern die Studierenden die in der Vorlesung erworbenen Kenntnisse und Fähigkeiten.	2 SWS
Prüfung: Klausur (90 Minuten)	6 C
Prüfungsanforderungen: • Darlegung eines übergreifenden Verständnisses grundlegender Fragestellungen der internationalen Rechnungslegung und des damit verbundenen institutionellen Rahmens, • Nachweis der Kenntnis zentraler Regelungen der Rechnungslegung nach IFRS und der Fähigkeit diese anzuwenden.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundkenntnisse der Buchführung sowie der Bilanzierung nach Handelsrecht und IFRS werden vorausgesetzt
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jörg-Markus Hitz
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	1 - 2
Maximale Studierendenzahl: nicht begrenzt	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.WIWI-BWL.0003: Unternehmensbesteuerung
English title: Company Taxation</td><td>6 C
4 SWS</td></tr>
</table>

<table>
<tr><td>Lernziele/Kompetenzen:
Mit Abschluss haben die Studierenden folgende Kompetenzen erworben:
• Quantifizierung von rechtlichen Steuerbelastungen (steuerzahlungen) mittels geeigneter Verfahren sowie die Fähigkeit, Vor- und Nachteile dieser Verfahren diskutieren zu können,
• Berechnung und Interpretation verschiedener Ausprägungen der wirtschaftlichen Steuerbelastung sowie ihrer Würdigung bezüglich ihrer Abhängigkeiten von steuerlichen Parametern,
• Kenntnis über die Preiswirkungen der Besteuerung sowie die Fähigkeit, sie in konkreten Sachverhalten herausarbeiten zu können,
• Kenntnis über ökonomisch bedeutsame Neutralitäten, die durch die Besteuerung nicht verletzt werden sollten,
• Fähigkeit, Verfahren aufzuzeigen und anzuwenden, die eine entscheidungsneutrale Besteuerung gewährleisten,
• Beurteilung von konkreten steuerlichen Gewinnermittlungsvorschriften hinsichtlich ihrer Entscheidungswirkungen anhand geeigneter Methoden und
• Durchführung von Steuerwirkungsanalysen und steuerlichen Vorteilhaftigkeitsvergleichen.</td><td>Arbeitsaufwand:
Präsenzzeit:
56 Stunden
Selbststudium:
124 Stunden</td></tr>
</table>

<table>
<tr><td>Lehrveranstaltung: Unternehmensbesteuerung (Vorlesung)
Inhalte:
Die Vorlesung soll den Studierenden die wirtschaftlichen Wirkungen der Besteuerung (Steuerlastlehre und Neutralitätsüberlegungen) sowie die grundlegenden Einflussfaktoren bei Steuerplanungsüberlegungen vermitteln. Hierzu gliedert sich die Vorlesung in vier Kapitel. Im ersten Kapitel erfolgt eine Einordnung der Besteuerung in die betriebswirtschaftliche Entscheidungstheorie. Im zweiten Kapitel werden Verfahren zur Messung von Steuerzahlungen und Steuerbelastungen behandelt und Formen steuerlicher Neutralität unterschieden, die aus ökonomischer Sicht durch die Besteuerung nicht verletzt werden sollten. Im dritten Kapitelwerdenden Studierendeninstitutionelle Grundlagen der Unternehmensbesteuerung vermittelt. Das vierte Kapitel bietet eine Einführung in Steuerwirkungsanalysen in Bezug auf rein nationale Sachverhalte.</td><td>2 SWS</td></tr>
<tr><td>Lehrveranstaltung: Unternehmensbesteuerung (Übung)
Inhalte:
Im Rahmen der begleitenden Übung vertiefen, ergänzen und erweitern die Studierenden die in der Vorlesung erworbenen Kenntnisse und Fähigkeiten. Insbesondere werden mit den Studierenden Übungsfälle erarbeitet und diskutiert, mithilfe derer ein tieferes Verständnis für die praktische Anwendung der in der Vorlesung theoretisch vermittelten Inhalte geschaffen wird.</td><td>2 SWS</td></tr>
</table>

Prüfung: Klausur (90 Minuten)	6 C
Prüfungsanforderungen: Die Studierenden erbringen den Nachweis von Kenntnissen der wirtschaftlichen Wirkungen der Besteuerung sowie grundlegender Steuerplanungsüberlegungen und zeigen, dass sie in der Lage sind, diese auf spezifische Sachverhalte anwenden können. Ferner erbringen die Studierenden den Nachweis über den Erwerb grundlegender Kenntnisse der Besteuerung alternativer Rechtsformen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundkenntnisse im Bereich Unternehmenssteuern werden vorausgesetzt
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Oestreicher
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 2
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen Module M.WIWI-BWL.0004: Financial Risk Management	6 C 4 WLH
Learning outcome, core skills: After a successful completion of the course students are able to: • understand and explain how risk management is related to other issues in corporate finance, • critically assess different motivations for corporate risk management, • understand and critically assess different risk measures and how they are applied in practice, • understand and explain how international risks can be managed and how the management of international risks is related to various economic parity conditions, • understand, analyze and critically apply measures and methods to manage interest rate risk, • understand, analyze and critically apply measures and methods to manage credit risk, • understand, analyze and critically apply hedging strategies for commodity price risk.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Financial Risk Management (Lecture) *Contents*: 1. Introduction 2. Risk Management: Motivation and Strategies 3. Managing Interest Rate Risk 4. Managing Credit Risk 5. Managing International Risks 6. Managing Commodity Price Risk Parts of the material covered by the lectures will be transmitted via recordings that students have to work through on their own. Parts of the contact hours during lectures will be used by the students to discuss open issues and to work on specific cases and applications of the main concepts.	2 WLH
Course: Financial Risk Management (Tutorial) *Contents*: In the accompanying practice sessions students deepen and broaden their knowledge from the lectures.	2 WLH
Examination: Written examination (90 minutes)	6 C
Examination requirements: • Demonstrate a profound knowledge of how risk management is related to other issues in corporate finance. • Document an understanding of viable reasons for corporate risk management and how corporate risk management can create value. • Demonstrate the ability to analyze and apply different risk measures.	

• Show a profound understanding of methods and techniques used to manage international risks, interest rate risk, credit risk, and commodity price risk.	

Admission requirements: none	**Recommended previous knowledge:** M.WIWI-BWL.0001 Corporate Finance
Language: English	**Person responsible for module:** Prof. Dr. Olaf Korn
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2 - 3
Maximum number of students: not limited	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.WIWI-BWL.0006: Seminar in Finanzwirtschaft
English title: Seminar in Finance</td><td>6 C
2 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Mit dem erfolgreichen Abschluss des Moduls haben die Studierenden folgende Kompetenzen erworben:
• sie können die Lösung für eine komplexe, übergreifende Fragestellung mit finanzwirtschaftlichem Schwerpunkt eigenständig erarbeiten und sind in der Lage, das erworbene Wissen schriftlich und mündlich sachgerecht zu kommunizieren,
• sie können ein Projekt erfolgreich managen und sind in der Lage eine Arbeitsgruppe zu koordinieren,
• sie können von anderen erarbeiteten Lösungen der Fragestellung auf ihre zentralen Aspekte reduzieren und kritisch kommentieren,
• sie können zu einer durch Referate angestoßenen Diskussion durch eigene qualifizierte Beiträge beitragen.</td><td>Arbeitsaufwand:
Präsenzzeit:
28 Stunden
Selbststudium:
152 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Seminar in Finanzwirtschaft (Seminar)
Inhalte:
Inhalt des Seminars ist die projektbezogene Erarbeitung einer Lösung für eine übergreifende, komplexe Problemstellung mit finanzwirtschaftlichem Schwerpunkt. Genaue Inhalte und Themen können von Semester zu Semester wechseln und werden zum Ende des vorangehenden Semesters bekannt gegeben.</td><td>2 SWS</td></tr>
<tr><td>Prüfung: Hausarbeit (max. 25 Seiten) mit Präsentation (ca. 45 Minuten)
Prüfungsvorleistungen:
Regelmäßige und aktive Teilnahme am Seminar.</td><td>6 C</td></tr>
<tr><td>Prüfungsanforderungen:
• Nachweis der Fähigkeit, eine komplexe finanzwirtschaftliche Fragestellung zu strukturieren und in verschiedene Teilfragen zu zerlegen.
• Nachweis der Fähigkeit, eigenständige Lösungen der finanzwirtschaftlichen Fragestellung zu entwickeln und umzusetzen sowie diese zu kommunizieren.</td><td></td></tr>
</table>

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** M.WIWI-BWL.0001 Sustainable Finance M.WIWI-BWL.0008 Derivate
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Olaf Korn
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2 - 3
Maximale Studierendenzahl: 16	

Georg-August-Universität Göttingen **Modul M.WIWI-BWL.0023: Performance Management** *English title: Performance Management*	6 C 4 SWS

Lernziele/Kompetenzen: Mit Abschluss haben die Studierenden die konzeptionellen Grundlagen der wesentlichen Kennzahlen im Bereich der wertorientierten Unternehmensführung kennengelernt. Durch die Kombination von wissenschaftlichen Kenntnissen und praxisnahen Inhalten haben die Studierenden Kenntnis über die positiven und negativen Wirkungen von Instrumenten des Value Based Managements erlangt. Des Weiteren haben die Studierenden Kenntnisse über Ansätze zur Messung von Nachhaltigkeit in der Unternehmenssteuerung erworben.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Performance Management (Vorlesung) *Inhalte*: Die Veranstaltung befasst sich mit wesentlichen Aspekten des Performancemanagements unternehmerischer Aktivitäten mit dem Fokus auf einer wertorientierten Perspektive ergänzt durch die zunehmend wichtiger werdende Nachhaltigkeitsperspektive. Die Veranstaltung ist in fünf Hauptkapitel gegliedert. Zuerst werden Grundlagen des Management Accounting und der wertorientierten Unternehmensführung diskutiert. Auf dieser Basis werden Ansätze für die kapitalmarkt- und bilanzorientierte Performancemessung vorgestellt und deren Grenzen aufgezeigt. Darauffolgend werden die konzeptionellen Grundlagen eines ganzheitlichen Value Based Managements und die entsprechenden Dimensionen einer konsistenten Implementierung vorgestellt. Ein weiterer Fokus wird auf die Messung der Nachhaltigkeit im Unternehmen gelegt. Abschließend erfolgt eine Einbettung der vorgestellten Ansätze in die Ausgestaltung von Performance Management Systemen.	2 SWS
Lehrveranstaltung: Performance Management (Übung) *Inhalte*: Die Übung dient dazu die Konzepte der wertorientierten Unternehmensführung auf praktische Fragestellungen anzuwenden, indem Übungsaufgaben gelöst und die Inhalte an praktischen Beispielen diskutiert werden. Im Sinne eines breiteren Einstiegs beginnt die Übung mit einer Abgrenzung der verschiedenen Stakeholdergruppen, um sich im Folgenden stärker auf die Shareholder-orientierten Inhalte der Unternehmensbewertung und deren Eignung für ein wertorientiertes Steuerungssystem zu diskutieren. Daraufhin werden traditionelle Kennzahlenkonzepte vorgestellt und mögliche Nachteile aufgezeigt. Auf dieser Basis werden die methodischen Grundlagen von wertorientierten Kennzahlen erörtert und deren Potentiale aufgezeigt. Den Gedanken der Stakeholder Orientierung wieder aufnehmend werden die Eigenschaften von Nachhaltigkeitskennzahlen genauer betrachtet. Zum Abschluss wird die Eignung der ganzheitlichen Implementierung von Value Based Management diskutiert.	2 SWS
Prüfung: Klausur (60 Minuten)	6 C

Prüfungsanforderungen:	

Nachweis von Kenntnissen der Konzepte, Dimensionen und Grenzen der Kapitalmarkt- und Bilanz-orientierten Performancemessung, des Value-Based Managements sowie von Nachhaltigkeitskennzahlen durch Nennen, Erläutern und Berechnen in entsprechenden Aufgaben. Außerdem das Anwenden des erworbenen Wissens auf praxisnahe Aufgabenstellungen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundkenntnisse in Controlling
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Michael Wolff
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 2
Maximale Studierendenzahl: nicht begrenzt	

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.WIWI-BWL.0133: Banking Supervision</td><td>6 C
2 WLH</td></tr>
</table>

<table>
<tr><td>Learning outcome, core skills:
After a successful completion of the course students are able to:
• understand and explain how banking supervision has developed over time and how it differs across jurisdictions,
• understand, explain and critically apply standard measures and methods of banking supervision,
• understand and explain the Euro area banking union,
• understand, explain and critically apply key concepts in banking regulation,
• understand, explain and critically apply key measures and methods to assess the risks of financial institutions,
• understand and explain micro-and macroprudential supervision and their differences.</td><td>Workload:
Attendance time:
28 h
Self-study time:
152 h</td></tr>
</table>

<table>
<tr><td>Course: Banking Supervision (Lecture)
Contents:
1. Introduction (e.g. banking structure)
2. Foundations of banking supervision
• Historical developments
• Comparison across different jurisdictions
3. Banking Union – SSM
4. Banking Regulation
• Basel III, CRDIV/CRR
• ASFR model by Gordy
• Further requirements on banks
5. SSM Guide on banking supervision
• How is banking supervision applied?
6. Risk Analysis
• Stress testing
• Bank Rating
7. Microprudential versus macroprudential supervision</td><td>2 WLH</td></tr>
<tr><td>Examination: Written examination (90 minutes)</td><td>6 C</td></tr>
</table>

<table>
<tr><td>Examination requirements:
• Document an understanding how banking supervision has developed over time and how it differs across jurisdictions
• Demonstrate a profound knowledge of standard measures and methods of banking supervision
• Show an understanding of the Euro area banking union
• Demonstrate the ability to explain and to some extent to apply key concepts in banking regulation</td><td></td></tr>
</table>

• Document the knowledge to apply key measures and methods to assess the risks of financial institutions and to interpret the obtained results appropriately • Document an understanding of micro-and macroprudential supervision and their differences	

Admission requirements: none	**Recommended previous knowledge:** M.WIWI-BWL.0001 Corporate Finance M.WIWI-BWL.0004 Financial Risk Management
Language: English	**Person responsible for module:** Dr. Philipp Koziol
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 3
Maximum number of students: not limited	

Georg-August-Universität Göttingen Module M.WIWI-BWL.0134: Panel Data Analysis in Marketing	6 C 2 WLH
Learning outcome, core skills: Panel data refers to observations from different individuals or units (consumers, stores, products, etc.) over several time periods (days, weeks, months, etc.). After successful attendance the students will understand the methodological principles of panel data analysis, especially in the context of consumer behavior and marketing-mix models. Further, they will be able to conduct own panel data analyses using the statistical programming language R.	**Workload:** Attendance time: 28 h Self-study time: 152 h
Course: Panel Data Analysis in Marketing (Lecture with exercise) *Contents*: • Introduction to R • Refreshment in Regression Analysis • Fixed Effects Models in Marketing • Random Effects Models in Marketing • Dynamic Panel Models in Marketing	2 WLH
Examination: Term Paper (max. 6000 words)	6 C
Examination requirements: A self-conducted empirical project. Students will be provided with empirical data, but are welcome to analyze own projects. Students are advised to use the statistical programming language R, but can be allowed to use different statistics software in exceptional cases. Theoretical, methodological and empirical elaboration of a selected topic in panel data analysis with focus on consumer behavior and/or marketing-mix modeling.	

Admission requirements: none	**Recommended previous knowledge:** Basics in Hypothesis testing & Regression analysis Previous knowledge in R is not required
Language: English	**Person responsible for module:** Ossama Elshiewy
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.WIWI-QMW.0001: Generalized Regression**	6 C 4 WLH

Learning outcome, core skills: Upon completion of the module, the students have acquired the following competencies: • overview on extended regression modelling techniques that allow to analyse data with non-normal responses, • approaches for modeling nonlinear effects in scatterplot smoothing, • introduction to additive models and mixed models for complex regression analyses, • implementation of these approaches using statistical software packages.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Generalized Regression (Lecture) *Contents*: Generalized linear models (binary and Poisson regression, exponential families, maximum likelihood estimation, iteratively weighted least squares regression, tests of hypotheses, confidence intervals, model selection and model checking, categorical regression models), nonparametric smoothing techniques (penalized spline smoothing, local smoothing approaches, general properties of scatterplot smoothers, choosing the smoothing parameter, bivariate and spatial smoothing, generalized additive models), mixed models, quantile regression	2 WLH
Course: Generalized Regression (Tutorial) *Contents*: Generalized linear models (binary and Poisson regression, exponential families, maximum likelihood estimation, iteratively weighted least squares regression, tests of hypotheses, confidence intervals, model selection and model checking, categorical regression models), nonparametric smoothing techniques (penalized spline smoothing, local smoothing approaches, general properties of scatterplot smoothers, choosing the smoothing parameter, bivariate and spatial smoothing, generalized additive models), mixed models, quantile regression	2 WLH
Examination: Written examination (90 minutes) or oral examination (approx. 20 minutes)	6 C

Examination requirements: In the exam, the students demonstrate their ability to choose, fit and interpret extended regression modeling techniques. They show a general understanding of the derived estimates and their interpretation in various contexts. The students are able to implement complex regression models using statistical software and to interpret the corresponding results. The exam covers contents of both the lecture and the exercise class.	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of statistical modelling using linear regression models

	M.WIWI-QMW.0002 Advanced Statistical Inference (Likelihood & Bayes)
Language: English	**Person responsible for module:** Prof. Dr. Thomas Kneib
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2
Maximum number of students: not limited	

Additional notes and regulations: The actual examination will be published at the beginning of the semester.

Georg-August-Universität Göttingen **Module M.WIWI-QMW.0002: Advanced Statistical Inference (Likelihood & Bayes)**	6 C 4 WLH

Learning outcome, core skills: Upon completion of the module, the students have acquired the following competencies: • foundations and general properties of likelihood-based inference in statistics, • bayesian approaches to statistical learning and their properties, • implementation of both approaches in statistical software using appropriate numerical procedures.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Advanced Statistical Inference (Likelihood & Baye) (Lecture) *Contents*: The likelihood function and likelihood principles, maximum likelihood estimates and their properties, likelihood-based tests and confidence intervals (derived from Wald, score, and likelihood ratio statistics), expectation maximization algorithm, Bootstrap procedures (estimates for the standard deviation, the bias and confidence intervals), Bayes theorem, Bayes estimates, Bayesian credible intervals, prior choices, computational approaches for Bayesian inference, model choice, predictions	2 WLH
Course: Advanced Statistical Inference (Likelihood & Bayes) (Exercise) *Contents*: The likelihood function and likelihood principles, maximum likelihood estimates and their properties, likelihood-based tests and confidence intervals (derived from Wald, score, and likelihood ratio statistics), expectation maximization algorithm, Bootstrap procedures (estimates for the standard deviation, the bias and confidence intervals), Bayes theorem, Bayes estimates, Bayesian credible intervals, prior choices, computational approaches for Bayesian inference, model choice, predictions	2 WLH
Examination: Written examination (90 minutes) or oral examination (approx. 20 minutes)	6 C

Examination requirements: The students demonstrate their general understanding of likelihood-based and Bayesian inference for different types of applications and research questions. They know about the advantages and disadvantages as well as general properties of both approaches, can critically assess the appropriateness for specific problems, and can implement them in statistical software. The exam covers contents of both the lecture and the exercise class.	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of mathematics and statistics
Language: English	**Person responsible for module:** Prof. Dr. Thomas Kneib
Course frequency: every year	**Duration:** 1 semester[s]

Number of repeat examinations permitted:	Recommended semester:
twice	1 - 2
Maximum number of students: not limited	

Additional notes and regulations:
The actual examination will be published at the beginning of the semester.

Georg-August-Universität Göttingen Module M.WIWI-QMW.0004: Econometrics I	6 C 6 WLH
Learning outcome, core skills: This course enables students to approach empirical research problems within the framework of the linear regression model, including model specification and selection, estimation, inference and detection of heteroscedasticity and autocorrelation. Moreover, the students can apply the methods discussed to real economic data and problems using the statistical software package R and they are able to assess estimator properties (finite sample and asymptotic). This course enables students to access more advanced topics in econometrics.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Econometrics I (Lecture) *Contents*: The lecture covers the following topics: 1. Introduction to the basic multiple regression model, model specification, OLS estimation, prediction and model selection, Multicollinearity and partial regression. 2. The normal linear model, including maximum likelihood and interval estimation, hypothesis testing. 3. Asymptotic properties of the OLS and (E)GLS estimators. 4. Generalized linear model: GLS and EGLS estimators, properties of these, heteroskedastic and autocorrelated models, testing for heteroscedasticity and autocorrelation.	2 WLH
Course: Econometrics I (Exercise) *Contents*: The practical deepens the understanding of the lecture topics by applying the methods from the lecture to economic problems and data, and reviewing and intensify theoretical concepts.	2 WLH
Course: Econometrics I (Tutorial) *Contents*: The tutorials are small classes with max. 20 students, which give room for applying the concepts to specific problem sets and discussing questions, that students might encounter regarding the concepts addressed in the lecture and practical. A part of the tutorial are hands-on computer exercises using the software R. This enables students to conduct regression analysis in practice and prepares them for others (applied) courses.	2 WLH
Examination: Written examination (90 minutes)	6 C
Examination requirements: The students demonstrate their understanding of basic econometric concepts. They show that they can apply these concepts to real economic problems.	

Admission requirements: none	**Recommended previous knowledge:** Basic knowlegde in statistics and mathematics
Language: English	**Person responsible for module:** Prof. Dr. Helmut Herwartz

Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: not limited	

Georg-August-Universität Göttingen Module M.WIWI-QMW.0005: Econometrics II	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
As the outcome of this advanced course the students are able to • identify problems of estimation and inference arising due to stochastic regressors, • establish finite sample and asymptotic properties of estimators under the assumption that the data generating process contains stochastic regressors, • model simple univariate stationary and non-stationary time series processes, • carry out and interpret test results of unit root and cointegration tests, • set up, and estimate (over-, under-) identified simultaneous equation models, • model simple multivariate time series with possible cointegration, • implement estimators and analyze real world datasets with the R programming language.	Attendance time: 56 h Self-study time: 124 h

Course: Econometrics (Lecture) *Contents*: Stochastic regressors in linear econometric models; OLS, IV, 2SLS, GMM estimators; Dynamic linear econometric models: stationary stochastic processes, ARMA models, (testing) unit roots, (testing) cointegration, spurious regression; Simultaneous equation models: Identification, estimation (GLS, IV, 2SLS, 3SLS, ILS) Vector autoregressive and error correction models: Interpretation, estimation, inference.	2 WLH
Course: Econometrics II (Exercise) *Contents*: Exercises deepening concepts from the lecture, and demonstrating practical applications. Simulations and data analysis exercises using the R programming language.	2 WLH
Examination: Written examination (90 minutes)	6 C

Examination requirements: The students demonstrate their understanding of advanced econometric concepts. They show that they can apply these concepts to real economic problems.	

Admission requirements: none	**Recommended previous knowledge:** M.WIWI-QMW.0004 Econometrics I
Language: English	**Person responsible for module:** Prof. Dr. Helmut Herwartz
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2 - 3
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.WIWI-QMW.0009: Introduction to Time Series Analysis**	6 C 4 WLH
Learning outcome, core skills: The students: • learn concepts and techniques related to the analysis of time series and forecasting, • gain a solid understanding of the stochastic mechanisms underlying time series data, • learn how to analyse time series using statistical software packages and how to interpret the results obtained.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Introduction to Time Series Analysis (Lecture) *Contents*: Classical time series decomposition analysis (moving averages, transformations of time series, parametric trend estimates, seasonal and cyclic components), exponential smoothing, stochastic models for time series (multivariate normal distribution, autocovariance and autocorrelation function), stationarity,spectral analysis, general linear time series models and their properties, ARMA models, ARIMA models, ARCH and GARCH models.	2 WLH
Course: Introduction to Time Series Analysis (Tutorial) *Contents*: Practical and theoretical exercises covering the content of the lecture. Implementation of time series models and estimation by common statistical software (e.g. R or Matlab). Interpretation of estimation results.	2 WLH
Examination: Written examination (90 minutes)	6 C
Examination requirements: The students show their ability to analyze time series using specific statistical techniques, can derive and interpret properties of stochastic models for time series, and can decide on appropriate models for given time series data. The students are able to implement time series analyses using statistical software and to interpret the corresponding results. The exam covers contents of both the lecture and the exercise class.	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in statistics M.WIWI-QMW.0004 Econometrics I
Language: English	**Person responsible for module:** Prof. Dr. Helmut Herwartz
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2 - 3

Maximum number of students: 50	

Georg-August-Universität Göttingen **Module M.WIWI-QMW.0011: Advanced Statistical Programming with R**	9 C 2 WLH
Learning outcome, core skills: The students acquire advanced understanding of programming concepts in the statistical programming environment R. They learn how to independently implement advanced statistical methodology and how to structure a large programming project. They furthermore develop abilities in debugging and optimizing R code and to present and document the results of their programming project.	**Workload:** Attendance time: 28 h Self-study time: 242 h
Course: Advanced Statistical Programming with R (Seminar) *Contents*: The students work on advanced statistical programming projects using methods and techniques they got to know in the "Introduction to R". This involves implementation of advanced statistical methodology, utilising tools for debugging and profiling code and documenting the code. The progress of the projects is documented in a presentation and a written report.	2 WLH
Examination: Term paper (max. 20 pages) or project work (project documentation in group work (max. 10 pages)) or development of a prototype (prototypical programming development including documentation (max. 20 pages)) **Examination prerequisites:** Two presentations (each ca. 20 minutes), regular attendance	9 C
Examination requirements: The students work on a programming project with the goal of implementing a given statistical approach in an R package. The programming project is worked on in groups of up to three students. The students document their work in terms of the documentation for their R package and a written report of approximately 15 pages.	

Admission requirements: none	**Recommended previous knowledge:** M.WIWI-QMW.0021 Introduction to Statistical Programming M.WIWI-QMW.0002 Advanced Statistical Inference (Likelihood & Bayes) M.MED.0001 Linear Models and their Mathematical Foundations
Language: English	**Person responsible for module:** Prof. Dr. Thomas Kneib
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2
Maximum number of students:	

30	

Georg-August-Universität Göttingen Module M.WIWI-QMW.0012: Multivariate Time Series Analysis	6 C 4 WLH

Learning outcome, core skills: The students: • learn concepts and techniques related to the analysis of multivariate time series and the forecasting thereof. • learn to characterize the dynamic interrelationship between the variables of dynamic systems, • learn to relate economic models with restrictions implied by its empirical counterpart, • learn how to analyse multivariate time series using by means of statistical software packages and to interpret the results obtained.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Multivariate Time Series Analysis (Lecture) *Contents*: Vector Autoregressive and Vector Moving Average representations Model selection and estimation, Unit roots in vector processes, Vector autoregressive vs. vector error correction modeling, structural vectorautoregressions, Impulse response analysis, forecasting, forecast error variance decomposition	2 WLH
Course: Multivariate Time Series Analysis (Tutorial) *Contents*: Practical and theoretical exercises covering the content of the lecture. Implementation of multivariate time series models and estimation in common statistical software (e.g. R or Matlab). Interpretation of estimation results.	2 WLH
Examination: Written examination (90 minutes)	6 C

Examination requirements: The students show their ability to analyze systems of time series using specific statistical techniques, can derive and interpret properties of stochastic models for time series, and can decide on appropriate models for given data. The students are able to implement time series analyses using statistical software and to interpret the corresponding results. The exam covers contents of both the lecture and the exercises.	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledgin in statistics M.WIWI-QMW.0004 Econometrics I M.WIWI-QMW.0009 Introduction to Time Series Analysis
Language: English	**Person responsible for module:** Prof. Dr. Helmut Herwartz
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

twice	3 - 4

Georg-August-Universität Göttingen Module M.WIWI-VWL.0001: Advanced Microeconomics	6 C 4 WLH
Learning outcome, core skills: This course covers advanced microeconomic models. In this regard students are provided with the skills required to understand these models including advanced methods of calculus and basic proof techniques. Students learn how to formalize and analyze individual decision making and strategic interactions. They will get acquainted with models of individual choice under certainty and uncertainty. Students will be able to analyze decision problems of firms. They can distinguish between partial analysis of isolated markets and a general analysis considering mutual dependencies of markets. Finally, students will be able to formalize strategic interactions and to predict their theoretical outcomes based on a variety of solution concepts.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Advanced Microeconomics (Lecture) *Contents*: This course presents a formal treatment of microeconomic theory. 1. Rational choice under certainty 2. Consumer theory 3. Rational choice under uncertainty 4. Partial equilibrium 5. General equilibrium 6. Game theory	2 WLH
Course: Advanced Microeconomics (Exercise) *Contents*: The exercise deepens the understanding of concepts presented in the lecture. Students will receive problem sets, which they are requested to prepare at home. The solutions of these problem sets will be discussed in class.	2 WLH
Examination: Written examination (90 minutes)	6 C
Examination requirements: • Demonstrate the capability to understand advanced economic models • Demonstrate the understanding of the main concepts of individual choice theory • Apply techniques developed in the lecture and in the exercise such as the method of Lagrange multipliers or the Edgeworth Box • Demonstrate the basic knowledge of the theory of partial and general equilibrium • Prove the ability to solve analytical exercises • Find the game theoretical solutions to strategic interactions • Conduct advanced calculations	

Admission requirements: none	**Recommended previous knowledge:** BA level microeconomics and mathematics
Language: English	**Person responsible for module:** Prof. Dr. Claudia Keser Prof. Marcela Ibanez Diaz

Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: not limited	

Georg-August-Universität Göttingen Module M.WIWI-VWL.0041: Panel Data Econometrics	6 C 4 WLH
Learning outcome, core skills: This course aims to study panel data econometric techniques in an intuitive and practical way and to provide students the skills and understanding to read and evaluate empirical literature and to carry out empirical research. The course is concerned with the application of econometric panel-data methods, including basic linear unobserved effects panel data models with exogenous and endogenous regressors; random effects and fixed effects methods for static and dynamic models and panel data methods for binary dependent variables. Students learn basic econometric terminology and estimation and test principles for efficient inference with panel data and the potential of panel data to deal with estimation biases related to unobserved heterogeneity in individual characteristics. Students read and understand project reports and journal articles that use the methods introduce in the course and to make use of the course content in their academic work, namely, in analyses that are part of their marter's or PhD thesis.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Panel Data Econometrics (Lecture) *Contents*: *Linear Panel Data Models* 1. Static Linear Panel Data Models 1.1 Introduction to Panel Data 1.2 Assumptions 1.3 Estimation and Testing *1.3.1 Pooled OLS* *1.3.2 Random Effects Estimation* *1.3.3 Fixed Effects Estimation. Testing for Serial Correlation* *1.3.4 First-Differencing Estimation* 1.4. Comparison of Estimators and Testing the Assumptions 1.5 Correlated Random Effects (CRE) or Mundlak's Approach 2. Endogeneity and Dynamics in Linear Panel Data Models 2.1. Equivalence Between GMM 3SLS and Standard Estimators 2.2 Chamberlain's Approach to UE Models 2.3. RE and FE Instrumental Variables Methods 2.4. Hausman and Taylor Models 2.5. First Differencing and IV 2.6. Dynamic Panel Data Models. Estimation under Sequential Exogeneity 3. Special Topics	2 WLH

3.1 Heterogeneous Panels 3.2 Random Trend Models 3.3 General Models with Specific Slopes 3.4 Robustness of Standard Fixed Effects Estimators 3.5 Testing for Correlated Random Slopes *Non-linear Panel Data Models* 4. Panel Data Models for Discrete Variables 4.1 Introduction. Binary Response Panel Data Models with Strictly Exogenous Variables 4.2 Linear Probability Model 4.3 Fixed versus Random Effects 4.4 Other issues: Endogenous explanatory variables/Selection Bias The course is organized as a series of lectures complemented with tutorials.	
Course: Panel Data Econometrics (Tutorial) *Contents*: The computer software package STATA will be used for practical work.	2 WLH
Examination: Term Paper (max. 10 pages, based on the tutorial)	2 C
Examination: Written examination (120 minutes)	4 C

Examination requirements:

After taking the course, students should be able to:

- formulate static and dynamic econometric models for panel data on the basis of economic theories, recognise the reasons why panel data is a richer data framework than pure cross-secton or pure time-series data,
- translate models for cross-section and for time-series into panel data models,
- use the computer software package STATA to estimate panel data models,
- estimate parameter in panel data models using real datasets and test hypotheses by using STATA,
- interpret and evaluate the results of empirical estimations of economic models, which is an important feature of the study and application of economics.

Admission requirements: none	**Recommended previous knowledge:** Previous knowledge of intermediate econometrics is required.
Language: English	**Person responsible for module:** Prof. Dr. Inmaculada Martinez-Zarzoso
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 2 - 4

Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.WIWI-VWL.0092: International Trade**	6 C 4 WLH
Learning outcome, core skills: After a successful completion of the course students have achieved following competences: • give an overview of the core theoretical concepts explaining international trade patterns by means of various sources of trade flows like different technologies or factor endowments, • understand and apply the concepts of comparative and absolute advantage, • analyze the effects of international trade on the trading partners with respect to (i) their production and overall welfare, (ii) the reallocation of resources in the production process, (iii) the change in factor prices, • evaluate and critically reflect the gains and losses of international trade, • evaluate the consequences of different trade policies like tariffs and subsidies.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: International Trade (Lecture) *Contents*: *The Ricardian model* Mathematical and graphical analysis of the trade equilibrium in a neoclassical model explaining inter-industry trade with one production factor and (i) two goods, as well as (ii) a continuum of goods. Analysis of the trade effects on production and consumption, wages and overall welfare gains from trade. *The Heckscher-Ohlin model* Mathematical and graphical analysis of the trade equilibrium in a neoclassical model with two production factors. Analysis of trade effects on production and consumption, factor prices, and of distributional effects as implied by the Stolper-Samuelson Theorem. Analysis of the effects of changes in resource endowments as implied by the Rybczynski Theorem. Empirical test of the Heckscher-Ohlin model.Generalization of the Heckscher-Ohlin model to many production factors and goods by means of the Heckscher-Ohlin-Vanek model. Empirical test of Heckscher-Ohlin-Vanek model. Derivation of the specific-factors model with more production factors than goods and analysis of changes in goods prices and factor endowments. *Imperfect competition in international trade* Mathematical and graphical analysis of the Krugman model with increasing returns to scale and monopolistic competition as an explanation of intra-industry trade. Non-formal extensions of the Krugman model with (i) consumer CES preferences and (ii) heterogeneous technologies across firms, and the Melitz model. Formal derivation of the empirical Gravity equation based on the endowment model and on the monopolistic competition model. *Trade policy under perfect competition* Graphical analysis of the introduction of tariffs and quotas to the trade equilibrium under perfect competition on economic welfare. Analysis of partial and general equilibrium effects.	2 WLH

Trade policy under imperfect competition Graphical analysis of the introduction of tariffs and quotas to the trade equilibrium under monopolistic market power on economic welfare. Formal derivation of the median voter model to analyze political decisions on the usage of trade policies.	
Course: International Trade (Exercise) *Contents*: In the accompanying practice session students deepen and broaden their knowledge from the lectures.	2 WLH
Examination: Written examination (90 minutes)	6 C

Examination requirements: • Demonstrate a profound knowledge of the core theoretical concepts in international trade, • show the ability to analyze the welfare and distributional effects of international trade by means of graphical and mathematical tools, • show the ability to analyze the effects of trade policies, • students should be able to assess the theoretical models with respect to empirical applications.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Udo Kreickemeier
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.WIWI-VWL.0099: Poverty & Inequality**	6 C 3 WLH

Learning outcome, core skills: The goal of this course is to provide students with a general understanding of poverty, inequality, and related economic issues. By the end of the course, students will be able to: • describe concepts of poverty and inequality, • describe drivers of poverty and inequality, • describe interlinkages between poverty, inequality, and socio-economic outcomes, • discuss development policy targeting poverty and inequality, • calculate measures of poverty and inequality.	**Workload:** Attendance time: 42 h Self-study time: 138 h

Course: Poverty & Inequality (Lecture) *Contents*: This course provides an in-depth analysis of inequality, poverty and related economic issues at the graduate level. The course covers • theories of justice, • methodological aspects of poverty and inequality measurement, • global aspects of poverty and inequality, • effects of inequality on socio-economic outcomes and growth, • gender inequalities, • health inequality, • inequality and poverty in rich countries, • development policy targeting poverty.	2 WLH
Course: Poverty & Inequality (Tutorial) *Contents*: The tutorial provides practical skills in poverty and inequality measurement. It includes lab sessions where poverty and inequality measures are calculated using statistical software (Stata).	1 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Demonstrating skills related to the measurement of poverty and inequality. Demonstrating an understanding of the concepts, drivers and consequences of poverty and inequality and their interlinkages based on the most recent scientific literature.	4 C
Examination: Practical examination (max. 5 pages) **Examination requirements:** Application of theoretical concepts to measure poverty and inequality using real data from developing countries and statistical software (Stata).	2 C

Admission requirements: none	**Recommended previous knowledge:** none
Language:	**Person responsible for module:**

English	Prof. Dr. Sebastian Vollmer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.WIWI-VWL.0128: Deep Determinants of Growth and Development**	6 C 2 WLH
Learning outcome, core skills: After a successful participation, students have a deeper understanding of the mechanisms that lead to long-run economic growth and development. They learn about the forces that are linked to economic development like governance, corruption, institutions, democracy, inequality, culture, and social capital.	**Workload:** Attendance time: 28 h Self-study time: 152 h
Course: Deep Determinants of Growth and Development (Lecture) *Contents*: In this course, we will study long-run trends in economic development. We will analyze questions such as • Why are some countries richer than others? • Why is a country today richer than several generations ago? • How can historical events affect the economy today? • What are the mechanisms that lead to the transition from stagnation towards sustained growth? **Contents:** 1. Governance 2. Property Rights 3. Inequality 4. Institutional Change 5. Culture and Social Capital **Literature:** The course is based upon selected research articles. Further information on the relevant literature is announced in the syllabus.	2 WLH
Examination: Oral exam (ca. 20 minutes) or written exam (90 minutes)	6 C
Examination requirements: Demonstrate: • a profound knowledge of the deep determinants of long-run development, • a deep understanding of the fundamental causes and consequences of long-run economic growth, • the ability to solve problems in a verbal, graphical and analytical manner.	

Admission requirements: none	**Recommended previous knowledge:** Macroeconomics, Mathematics for Economists, Economic Growth, Econometrics as taught in the Bachelor courses

Language: English	**Person responsible for module:** Prof. Dr. Holger Strulik
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 4

Fakultät für Physik:

Nach Beschlüssen des Fakultätsrats der Fakultät für Physik vom 08.11.2023, 06.12.2023 und 17.01.2024 hat das Präsidium der Georg-August-Universität Göttingen am 07.02.2024 die Neufassung des Modulverzeichnisses zur Prüfungs- und Studienordnung für den Bachelor-Studiengang „Physik" genehmigt (§ 44 Abs. 1 Satz 2 NHG, §§ 37 Abs. 1 Satz 3 Nr. 5 b), 44 Abs. 1 Satz 3 NHG).

Georg-August-Universität
Göttingen

Modulverzeichnis

zu der Prüfungs- und Studienordnung für den Bachelor-Studiengang "Physik" (Amtliche Mitteilungen I Nr. 54/2016 S. 1485, zuletzt geändert durch Amtliche Mitteilungen I Nr. 44/2022 S. 862)

Module

Übersicht nach Modulgruppen

I. Bachelor-Studiengang "Physik"

Es müssen nach Maßgabe der folgenden Bestimmungen wenigstens 180 C erworben werden.

1. Kerncurriculum

Es müssen Module im Umfang von insgesamt 132 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

a. Experimentelle und theoretische Physik (inkl. Praktika)

Es müssen folgende Pflichtmodule im Umfang von insgesamt 68 C erfolgreich absolviert werden:

b. Mathematik

Es müssen folgende Pflichtmodule im Umfang von insgesamt 36 C erfolgreich absolviert werden.

Soweit die Module B.Mat.0011 (Analysis I), B.Mat.0012 (Analytische Geometrie und Lineare Algebra I) und B.Mat.0021 (Analysis II) im Rahmen eines weiteren Studiengangs oder Teilstudiengangs zu absolvieren sind, werden diese gemeinsam anstelle der Module B.Mat.0831 sowie B.Mat.0832 angerechnet. Das erfolgreich absolvierte Modul B.Mat.2110 (Funktionenanalysis) wird anstelle des Moduls B.Mat.0833 angerechnet.

c. Kern-/Teilchen- und Festkörperphysik

Es müssen folgende Pflichtmodule im Umfang von insgesamt 16 C erfolgreich absolviert werden:

d. Programmieren und wissenschaftliches Rechnen

Es müssen Module im Umfang von insgesamt wenigstens 12 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

aa. Programmieren

Es muss eines der folgenden Wahlpflichtmodule im Umfang von 6C erfolgreich absolviert werden:

bb. CWR

Es muss folgendes Pflichtmodul im Umfang von 6 C erfolgreich absolviert werden:

2. Profilierungsbereich

Es müssen Module im Umfang von insgesamt wenigstens 24 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

a. Studium ohne Studienschwerpunktbildung

aa. Profilierungsbereich

Es müssen aus dem Lehrangebot der mathematisch-naturwissenschaftlichen Fakultäten (inkl. der Fakultät für Physik) Module im Umfang von insgesamt wenigstens 18 C erfolgreich absolviert werden. Hiervon ausgenommen sind Studierende, die das Studium mit Studienschwerpunkt absolvieren.

bb. Alternativmodule

Anstelle der oben genannten Module können auf Antrag, der an die Studiendekanin oder den Studiendekan der Fakultät für Physik zu richten ist, andere Module (Alternativmodule) nach Maßgabe der nachfolgenden Bestimmungen absolviert werden. Dem Antrag ist die Zustimmung der Studiendekanin oder des Studiendekans der Fakultät oder Lehreinheit, die das Alternativmodul anbietet, beizufügen. Die Entscheidung trifft die Studiendekanin oder der Studiendekan der Fakultät für Physik. Der Antrag kann ohne Angabe von Gründen abgelehnt werden; ein Rechtsanspruch der Antragstellerin oder des Antragstellers auf Zulassung eines Alternativmoduls besteht nicht.

cc. Wissenschaftliches Arbeiten

Es muss eines der unter Nr. 4 genannten Module im Umfang von 6 C erfolgreich absolviert werden.

b. Studium mit Studienschwerpunktbildung

Der Bachelor-Studiengang "Physik" kann mit einem der vier Studienschwerpunkte "Astro- und Geophysik", "Biophysik und Physik komplexer Systeme", "Festkörper- und Materialphysik" oder "Kern- und Teilchenphysik" studiert werden. Für die Zertifizierung eines Schwerpunkts müssen abweichend von Buchstabe a jeweils mindestens 24 C nach Maßgabe der folgenden Bestimmungen im jeweiligen Schwerpunkt und das den gewählten Schwertpunkt betreffende Modul "Einführung ins wissenschaftliche Arbeiten" erfolgreich absolviert werden sowie die Bachelorarbeit im jeweiligen Schwerpunktbereich angefertigt werden.

aa. Studienschwerpunkt Astro- und Geophysik

Es müssen Module im Umfang von insgesamt wenigstens 24 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Wahlpflichtmodule A

Es müssen folgende zwei Wahlpflichtmodule im Umfang von insgesamt 12 C erfolgreich absolviert werden:

ii. Wahlpflichtmodule B

Es muss wenigstens eines der unter Nr. 1 Buchstabe b. Buchstaben aa. Ziffer i aufgeführten Module mit Modulnummern der Formate B.Phy.55X bzw. B.Phy.55XX sowie B.Phy.1541 im Umfang von insgesamt wenigstens 6 C erfolgreich absolviert werden.

iii. Wissenschaftliches Arbeiten

Es muss das Modul B.Phy.405 unter Nr. 4 im Umfang von 6 C erfolgreich absolviert werden.

bb. Studienschwerpunkt Biophysik und Physik komplexer Systeme

Es müssen Module im Umfang von insgesamt wenigstens 24 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Pflichtmodul

Es muss folgendes Pflichtmodul im Umfang von 4 C erfolgreich absolviert werden

ii. Wahlpflichtmodule A

Es muss mindestens eines der folgenden Wahlpflichtmodule im Umfang von 6 C erfolgreich absolviert werden:

iii. Wahlpflichtmodule B

Es muss wenigstens eines der unter Nr. 1 Buchstabe b. Buchstaben aa. Ziffer i aufgeführten Module mit Modulnummern der Formate B.Phy.56X bzw. B.Phy.56XX oder ein weiteres Modul aus Buchstabe b. Buchstaben bb. Ziffer ii. im Umfang von insgesamt wenigstens 6 C erfolgreich absolviert werden.

iv. Wissenschaftliches Arbeiten

Es muss das Modul B.Phy.406 unter Nr. 4 im Umfang von 6 C erfolgreich absolviert werden.

cc. Studienschwerpunkt Festkörper- und Materialphysik

Es müssen Module im Umfang von insgesamt wenigstens 24 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Pflichtmodul

Es muss folgendes Pflichtmodul im Umfang von 4 C erfolgreich absolviert werden:

ii. Wahlpflichtmodule A

Es muss mindestens eines der drei folgenden Wahlpflichtmodule im Umfang von mindestens 4 C erfolgreich absolviert werden:

iii. Wahlpflichtmodule B

Es muss wenigstens eines der unter Nr. 1 Buchstabe b. Buchstaben aa. Ziffer i aufgeführten Module mit Modulnummern der Formate B.Phy.57X bzw. B.Phy.57XX oder ein weiteres Modul aus Buchstabe b. Buchstaben cc. Ziffer ii. im Umfang von insgesamt wenigstens 8 C erfolgreich absolviert werden.

iv. Wissenschaftliches Arbeiten

Es muss das Modul B.Phy.407 unter Nr. 4 im Umfang von 6 C erfolgreich absolviert werden.

dd. Studienschwerpunkt Kern-/Teilchenphysik

Es müssen Module im Umfang von insgesamt wenigstens 24 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Pflichtmodule

Es müssen folgende zwei Pflichtmodule im Umfang von insgesamt 10 C erfolgreich absolviert werden:

ii. Wahlpflichtmodule

Es muss wenigstens eines der unter Nr. 1 Buchstabe b. Buchstaben aa. Ziffer i aufgeführten Module mit Modulnummern der Formate B.Phy.58X bzw. B.Phy.58XX. im Umfang von insgesamt wenigstens 8 C erfolgreich absolviert werden.

iii. Wissenschaftliches Arbeiten

Es muss das Modul B.Phy.408 unter Nr. 4 im Umfang von 6 C erfolgreich absolviert werden.

3. Schlüsselkompetenzen

Es müssen Module im Umfang von insgesamt wenigstens 12 C aus dem Lehrangebot der Universität außerhalb der Fakultät für Physik erfolgreich absolviert werden. Wählbar sind insbesondere die nachfolgenden Module sowie Angebote aufgrund der Prüfungsordnung für Studienangebote der Zentralen Einrichtung für Sprachen und Schlüsselqualifikationen (ZESS); darüber hinaus wird ein Verzeichnis wählbarer Module durch die Fakultät für Physik in geeigneter Weise bekannt gemacht.

4. Einführung ins wissenschaftliche Arbeiten

Es muss eines der folgenden Module zur „Einführung ins wissenschaftliche Arbeiten“ im Fachgebiet der Bachelorarbeit bzw. des gewählten Studienschwerpunktes im Umfang von 6 C erfolgreich absolviert werden. Die erworbenen 6 C werden dem Profilierungsbereich zugerechnet.

5. Bachelorarbeit

Durch die erfolgreiche Anfertigung der Bachelorarbeit werden 12 C erworben. Die Bachelorarbeit ist in einem Fachgebiet, in dem das Modul "Einführung ins wissenschaftliche Arbeiten" absolviert wurde, im Falle der Wahl eines Studienschwerpunktes in dessen Fachgebiet anzufertigen.

II. Ergänzende Hinweise zu Modulprüfungen

Soweit in diesem Modulverzeichnis Modulbeschreibungen in englischer Sprache veröffentlicht werden, gilt für die verwendeten Prüfungsformen nachfolgende Zuordnung:

written exam - Klausur

written elaboration - schriftliche Ausarbeitung

presentation (with discussion) - Präsentation (mit Diskussion)

term paper - Hausarbeit

oral exam - mündliche Prüfung

handout - Handout

Georg-August-Universität Göttingen **Modul B.Che.2301: Chemische Reaktionskinetik** *English title: Kinetics of Chemical Reactions*	6 C 5 SWS

Lernziele/Kompetenzen: Die Studierenden können chemische Elementarreaktionen, Transportvorgänge und Reaktionsmechanismen in verschiedenen Aggregatzuständen analysieren bzw. auf molekularer Basis verstehen. Sie sind mit Anwendungen der Reaktionskinetik in Gebieten wie der Photochemie, Atmosphärenchemie und Umweltchemie vertraut.	**Arbeitsaufwand:** Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden

Lehrveranstaltung: Vorlesung: Chemische Reaktionskinetik (Vorlesung)	3 SWS
Lehrveranstaltung: Übung zu: Chemische Reaktionskinetik (Übung)	2 SWS
Prüfung: Klausur (180 Minuten)	6 C

Prüfungsanforderungen: Formale Reaktionskinetik, experimentelle Methoden der Reaktionskinetik, theoretische Beschreibung von Elementarreaktionen und Transportvorgängen, Anwendungen der Reaktionskinetik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Alec Wodtke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Che.4104: Allgemeine und Anorganische Chemie (Lehramt und Nebenfach)** *English title: Introduction to General and Inorganic Chemistry*	6 C 6 SWS
Lernziele/Kompetenzen: Die Studierenden verstehen die allgemeinen Prinzipien und Gesetzmäßigkeiten der Chemie und sind mit grundlegenden Begriffen der allgemeinen und anorganischen Chemie vertraut. Sie erwerben erste Kenntnisse der anorganischen Stoffchemie.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: "Experimentalchemie I (Allgemeine und Anorganische Chemie)" (Vorlesung)	4 SWS
Lehrveranstaltung: "Experimentalchemie I (Allgemeine und Anorganische Chemie)" (Übung)	2 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** Erfolgreiche Teilnahme an den Übungen; Näheres regelt die Übungs-Ordnung	6 C
Prüfungsanforderungen: Allgemeine Chemie: Atombau und Periodensystem, Elemente und Verbindungen, Chemische Gleichungen und Stöchiometrie, Lösungen und Lösungsvorgänge, chemische Gleichgewichte, einfache Thermodynamik und Kinetik, Säure-Base-Reaktionen, Fällungs- und Komplexbildungsreaktionen, Redoxreaktionen; Grundlagen der Anorganischen Chemie: Vorkommen, Darstellung, Eigenschaften einiger Elemente und ihrer wichtigsten Verbindungen.	

Zugangsvoraussetzungen: Keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Dietmar Stalke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:**

Georg-August-Universität Göttingen **Modul B.Che.9107: Chemisches Praktikum für Studierende der Physik und Geowissenschaften** *English title: Laboratory course in General and Inorganic Chemistry for Physisists and Geologists*	6 C 8 SWS
Lernziele/Kompetenzen: Verstehen der allgemeinen Prinzipien und Gesetzmäßigkeiten der allgemeinen und anorganischen Chemie, sicherer Umgang mit deren Begriffen. Anwendung der im Modul B.Che.4104 erworbenen Kenntnisse der anorganischen Stoffchemie, Kennenlernen experimenteller Arbeitstechniken anhand von Schlüsselreaktionen. Integrative Vermittlung von Schlüsselkompetenzen: Teamarbeit; gute wissenschaftliche Praxis; Protokollführung; sicheres Arbeiten im Labor.	**Arbeitsaufwand:** Präsenzzeit: 112 Stunden Selbststudium: 68 Stunden
Lehrveranstaltung: Chemisches Praktikum für Studierende der Physik und Geowissenschaften *Angebotshäufigkeit:* jedes Semester	6 SWS
Lehrveranstaltung: Seminar zum Chemischen Praktikum für Studierende der Physik und Geowissenschaften (Seminar) *Angebotshäufigkeit:* jedes Semester	2 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** Erfolgreiche Teilnahme am Praktikum, Details siehe Praktikumsordnung **Prüfungsanforderungen:** Atombau und Periodensystem, Grundbegriffe, Elemente und Verbindungen, Aufbau der Materie, einfache Bindungskonzepte, Chemische Gleichungen und Stöchiometrie, Chemische Gleichgewichte, einfache Thermodynamik und Kinetik, Säure-Base-Reaktionen inklusive Puffer, Redoxreaktionen, Löslichkeit, einfache Elektrochemie, Vorkommen, Darstellung und Eigenschaften der Elemente und ihrer wichtigsten Verbindungen, Einführung in spektroskopische Methoden.	6 C

Zugangsvoraussetzungen: B.Che.4104	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Franc Reimer Meyer
Angebotshäufigkeit: jedes Wintersemester (Blockpraktikum in vorlesungsfreier Zeit) und jedes Sommersemester (in der Vorlesungszeit)	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:**

Bemerkungen:
Das Seminar wird von den Dozierenden und Assistent/innen der Anorganischen Chemie durchgeführt.

Ansprechpersonen für das Praktikum sind Frau Dr. Stückl sowie die entsprechenden Assistent/innen.

Georg-August-Universität Göttingen **Modul B.Inf.1101: Grundlagen der Informatik und Programmierung** *English title: Introduction to Computer Science and Programming*	10 C 6 SWS
Lernziele/Kompetenzen: Studierende • kennen grundlegende Begriffe, Prinzipien und Herangehensweisen der Informatik, kennen einige Programmierparadigmen und Grundzüge der Objektorientierung. • erlangen elementare Grundkenntnisse der Aussagenlogik, verstehen die Bedeutung für Programmsteuerung und Informationsdarstellung und können sie in einfachen Situationen anwenden. • verstehen wesentliche Funktionsprinzipien von Computern und der Informationsdarstellung und deren Konsequenzen für die Programmierung. • erlernen die Grundlagen einer Programmiersprache und können einfache Algorithmen in dieser Sprache codieren. • kennen einfache Datenstrukturen und ihre Eignung in typischen Anwendungssituationen, können diese programmtechnisch implementieren. • analysieren die Korrektheit einfacher Algorithmen und bewerten einfache Algorithmen und Probleme nach ihrem Ressourcenbedarf.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 216 Stunden
Lehrveranstaltung: Informatik I (Vorlesung, Übung)	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Nachweis von 50% der in den Übungsaufgaben erreichbaren Punkte. Kontinuierliche Teilnahme an den Übungen. **Prüfungsanforderungen:** In der Prüfung wird das Verständnis der vermittelten Grundbegriffe sowie die aktive Beherrschung der vermittelten Inhalte und Techniken nachgewiesen, z.B. • Kenntnis von Grundbegriffen nachweisen durch Umschreibung in eigenen Worten. • Standards der Informationsdarstellung in konkreter Situation umsetzen. • Ausdrücke auswerten oder Bedingungen als logische Ausdrücke formulieren usw. • Programmablauf auf gegebenen Daten geeignet darstellen. • Programmcode auch in nicht offensichtlichen Situationen verstehen. • Fehler im Programmcode erkennen/korrigieren/klassifizieren. • Datenstrukturen für einfache Anwendungssituationen auswählen bzw. geeignet in einem Kontext verwenden. • Algorithmen für einfache Probleme auswählen und beschreiben (ggf. nach Hinweisen) und/oder einen vorgegebenen Algorithmus (ggf. fragmentarisch) programmieren bzw. ergänzen. • einfache Algorithmen/Programme nach Ressourcenbedarf analysieren. • einfachsten Programmcode auf Korrektheit analysieren. • einfache Anwendungssituation geeignet durch Modul- oder Klassenschnittstellen modellieren. Die Klausur wird als **E-Prüfung** durchgeführt.	10 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Carsten Damm
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** ab bis
Maximale Studierendenzahl: 300	

Georg-August-Universität Göttingen **Modul B.Inf.1102: Grundlagen der Praktischen Informatik** *English title: Introduction to Computer Systems*	10 C 6 SWS
Lernziele/Kompetenzen: Die Studierenden • beherrschen die Grundlagen einer deklarativen Programmiersprache und können Programme erstellen, testen und analysieren. • beherschen die Grundlagen einer Programmiersprache, die als Skriptsprache nutzbar ist, und können Skripte erstellen, testen und analysieren. • kennen Aufgaben und Struktur eines Betriebssystems, die Verfahren zur Verwaltung, Scheduling und Synchronisation von Prozessen und zur Speicherverwaltung, sie können diese Verfahren jeweils anwenden, analysieren und vergleichen. • kennen Grundlagen und verschiedene Beschreibungen von formalen Sprachen, z.B. Automaten und Grammatiken, und können diese konstruieren, analysieren und vergleichen. • kennen Grundlagen des Compilerbaus und können einfache Versionen der zugehörigen Softwarewerkzeuge, z.B. Lexer, Parser, Interpeter und Compiler, konstruieren und analysieren. • kennen verschiedene Teilgebieten der formalen Logik, z.B. Aussagen- und Prädikatenlogik, und darauf beruhende Verfahren, z.B. Auswertung, Konstruktion und Resolution, und können diese anwenden. • kennen die Schichtenarchitektur von Computernetzwerken, sowie sowohl Dienste als auch Protokolle und können diese analysieren und vergleichen. • kennen unterschiedliche Verschlüsselungsverfahren, z.B. symmetrische und asymmetrische, sowie Methoden sowohl zum Schlüsselaustausch als auch zur Schlüsselvereinbarung und können diese anwenden, analysieren und vergleichen. • kennen die Grundlagen einzelnen Teilgebiete der Softwaretechnik, z.B. Softwaretest, und können diese anwenden und analysieren.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 216 Stunden
Lehrveranstaltung: Grundlagen der Praktischen Informatik (Vorlesung, Übung)	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Nachweis von 50% der in den Übungsaufgaben erreichbaren Punkte. Kontinuierliche Teilnahme an den Übungen. **Prüfungsanforderungen:** Deklarative Programmierung, Programmierung von Skripten, Betriebssysteme, formale Sprachen, Compilerbau, formale Logik, Telematik, Kryptographie, Softwaretechnik Die Klausur wird als **E-Prüfung** durchgeführt.	10 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Inf.1101
Sprache:	**Modulverantwortliche[r]:**

Deutsch	Dr. Henrik Brosenne
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 300	

Georg-August-Universität Göttingen **Modul B.Mat.0721: Mathematisch orientiertes Programmieren** *English title: Mathematics related programming*	6 C 3 SWS

Lernziele/Kompetenzen:

Lernziele:

Das erfolgreiche Absolvieren des Moduls ermöglicht den Studierenden den sicheren Umgang mit mathematischen Anwendersystemen. Die Studierenden

- erwerben die Befähigung zum sicheren Umgang mit mathematischen Anwendersystemen,
- erfassen die Grundprinzipien der Programmierung,
- sammeln Erfahrungen mit elementaren Algorithmen und deren Anwendungen,
- verstehen die Grundlagen der Programmierung in einer high-level Programmiersprache,
- lernen Kontroll- und Datenstrukturen kennen,
- erlernen die Grundzüge des imperativen und funktionalen Programmierens,
- setzen Bibliotheken zur Lösung naturwissenschaftlicher Fragestellungen ein,
- erlernen verschiedene Methoden der Visualisierung,
- beherrschen die Grundtechniken der Projektverwaltung (Versionskontrolle, Arbeiten im Team).

Kompetenzen:

Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Techniken für das Lösen mathematisch/physikalischer Problemstellungen mit der Hilfe einer high-level Programmiersprache erlernt.

Arbeitsaufwand:
Präsenzzeit:
42 Stunden
Selbststudium:
138 Stunden

Lehrveranstaltung: Blockkurs *Inhalte*: Blockkurs bestehend aus Vorlesung, Übungen und Praktikum, z.B. "Mathematisch orientiertes Programmieren"	2 SWS
Prüfung: Klausur (90 Minuten) oder mündliche Prüfung (ca. 20 min)	6 C

Prüfungsanforderungen:
Nachweis über den Erwerb der folgenden Kenntnisse und Fähigkeiten. Die Teilnehmer/innen weisen grundlegende Techniken für das Lösen mathematisch/physikalischer Problemstellungen mit der Hilfe einer Programmiersprache nach.

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0011, B.Mat.0012
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	Bachelor: 1 - 6; Master: 1 - 4
Maximale Studierendenzahl: 120	

Bemerkungen: Dozent/in: Lehrpersonen des Instituts für Numerische und Angewandte Mathematik

Georg-August-Universität Göttingen **Modul B.Mat.0831: Mathematik für Studierende der Physik I** *English title: Mathematics for physics students I*	12 C 10 SWS
Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit analytischem mathematischen Grundwissen vertraut. Sie • wenden ihr Wissen über Mengen und Logik in verschiedenen Beweistechniken an; • gehen sicher mit Ungleichungen reeller Zahlen sowie mit Folgen und Reihen reeller und komplexer Zahlen um; • untersuchen reelle und komplexe Funktionen in einer Veränderlichen auf Stetigkeit; • kennen Differenzierbarkeit und Integrierbarkeit reeller Funktionen in einer Veränderlichen; • berechnen Integrale und Ableitungen von reellen Funktionen in einer Veränderlichen; • kennen algebraische Strukturen wie reelle und komplexe Vektorräume, Skalarprodukte und Orthonormalbasen ; • sind mit linearen Abbildungen vertraut; • kennen Gruppen, insbesondere Matrixgruppen, und beherrschen das Rechnen mit Matrizen und Determinanten; • beherrschen Methoden der Diagonalisierung; • lösen lineare Gleichungssystemen und Systeme linearer Differenzialgleichungen. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden grundlegende Kompetenzen im Bereich der Analysis sowie der analytische Geometrie und der linearen Algebra erworben. Sie • formulieren mathematische Sachverhalte aus Bereichen der Analysis und der linearen Algebra in schriftlicher und mündlicher Form korrekt; • lösen Probleme anhand von Fragestellungen der reellen, eindimensionalen Analysis und der linearen Algebra; • analysieren klassische Funktionen und ihre Eigenschaften mit Hilfe von funktionalem Denken; • erfassen grundlegende Eigenschaften von Zahlenfolgen und Funktionen; • erfassen lineare Strukturen und grundlegende strukturelle Eigenschaften linearer Vektorräume; • sind mit mathematischer Abstraktion, insbesondere vom drei-dimensionalem Erfahrungsraum zu endlich-dimensionalen Vektorräumen, vertraut.	**Arbeitsaufwand:** Präsenzzeit: 140 Stunden Selbststudium: 220 Stunden
Lehrveranstaltung: Mathematik für Studierende der Physik I (Vorlesung)	6 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:**	12 C

B.Mat.0831.Ue; Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorstellen von Lösungen in den Übungen	

Lehrveranstaltung: Mathematik für Studierende der Physik I - Übung (Übung)	2 SWS

Lehrveranstaltung: Mathematik für Studierende der Physik I - Saalübung (Die Saalübung ist ein optionales Angebot zum Wiederholen des Vorlesungsstoffes und zum Kennenlernen von Anwendungsmöglichkeiten.)	2 SWS

Prüfungsanforderungen: • Grundkenntnisse der Analysis, insbesondere Verständnis des Grenzwertbegriffs, Beherrschen von Beweistechniken; • Grundkenntnisse der linearen Algebra, insbesondere über Lösbarkeit und Lösungen von Gleichungssystemen; • Befähigung zur Anwendung der Grundkenntnisse in einfachen Beispielen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 1 - 3
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:

- Dozent*in: Lehrpersonen des Mathematischen Instituts
- Exportmodul für den Bachelorstudiengang Physik (B.Sc.)
- Die Module B.Mat.0831 und B.Mat.0832 können durch B.Mat.0011, B.Mat.0012 und B.Mat.0021 ersetzt werden.

Georg-August-Universität Göttingen **Modul B.Mat.0832: Mathematik für Studierende der Physik II** *English title: Mathematics for physics students II*	12 C 8 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele: Nach erfolgreichem Absolvieren des Moduls haben die Studierenden ihr mathematisches Grundwissen vertieft. Sie • beherrschen topologische Grundbegriffe in metrischen Räumen; • verstehen die Konzepte von Stetigkeit und Konvergenz in metrischen Räumen; • kennen den Banachschen Fixpunktsatz; • lösen gewöhnliche Differenzialgleichungen; • kennen Grundtechniken der Differenzialrechnung in mehreren Veränderlichen, insbesondere den Satz über implizite Funktionen; • lösen Extremwertaufgaben unter Nebenbedingungen; • kennen Grundtechniken der Integralrechnung in mehreren Veränderlichen; • berechnen Volumen-, Oberflächen- und Linienintegrale; • kennen Elemente der Vektoranalysis, insbesondere die Sätze von Gauß und Stokes sowie Kugelkoordinaten; • gehen sicher mit Bilinearformen um und kennen Invariantengruppen. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden ihre Kompetenzen im Bereich der Analysis vertieft. Sie beherrschen die mathematische Sprache, insbesondere die Darstellung von mathematischen Sachverhalten in der mehrdimensionalen Analysis.	Präsenzzeit: 112 Stunden Selbststudium: 248 Stunden

Lehrveranstaltung: Mathematik für Studierende der Physik II (Vorlesung)	6 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.0832.Ue; Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorstellen von Lösungen in den Übungen	12 C

Lehrveranstaltung: Mathematik für Studierende der Physik II - Übung (Übung)	2 SWS

Prüfungsanforderungen: • Grundkenntnisse der Analysis in mehreren Variablen; • Beherrschung der mathematischen Sprache; • Darstellung von mathematischen Sachverhalten in der mehrdimensionalen Analysis.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0831: Mathematik für Studierende der Physik I
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in

Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 2 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: • Dozent*in: Lehrpersonen des Mathematischen Instituts • Exportmodul für den Bachelorstudiengang Physik • Die Module B.Mat.0831 und B.Mat.0832 können durch B.Mat.0011, B.Mat.0012 und B.Mat.0021 ersetzt werden.

Georg-August-Universität Göttingen **Modul B.Mat.0833: Mathematik für Studierende der Physik III** *English title: Mathematics for physics students III*	6 C 6 SWS

Lernziele/Kompetenzen: **Lernziele:** Nach erfolgreichem Absolvieren des Moduls haben die Studierenden Grundwissen in Funktionentheorie und in Funktionalanalysis erworben. Sie • gehen sicher mit Potenzreihen um; • kennen die Cauchy-Integralformel und den Residuensatz; • kennen den Schwarzraum und (temperierte) Distributionen; • lösen spezielle partielle Differenzialgleichungen, insbes. Wellen-, Wärme- und Laplace-Gleichung, auch unter Randbedingungen; • wenden die Methode der Greenschen Funktion an; • beherrschen grundlegende Eigenschaften von Banachräumen und kompakten Operatoren; • kennen den Spektralsatz am Beispiel der Sturm-Liouville-Operatoren; • gehen sicher mit Fourier-Reihen und Fourier-Integralen um. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls beherrschen die Studierenden die mathematische Sprache, insbesondere die Darstellung von mathematischen Sachverhalten der höheren Analysis. Sie können Konzepte aus der Funktionentheorie und aus der Funktionalanalysis in konkreten Problemen anwenden.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Mathematik für Studierende der Physik III (Vorlesung)	4 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.0833.Ue; Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorstellen von Lösungen in den Übungen	6 C

Lehrveranstaltung: Mathematik für Studierende der Physik III - Übung (Übung)	2 SWS

Prüfungsanforderungen: • Grundkenntnisse der höheren Analysis; • Darstellung von mathematischen Sachverhalten in der Funktionentheorie und in der Funktionalanalysis; • Anwendung des Grundwissens aus Funktionentheorie und aus Funktionalanalysis auf konkrete Probleme.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0832: Mathematik für Studierende der Physik II
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan*in

Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 3 - 5
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:
• Dozenten/in: Lehrpersonen des Mathematischen Instituts • Exportmodul für den Bachelorstudiengang Physik • Das Modul B.Mat.0833 kann durch das Modul B.Mat.2110 ersetzt werden.

Georg-August-Universität Göttingen **Modul B.Phy.1101: Experimentalphysik I - Mechanik (mit Praktikum)** *English title: Experimental Physics I - Mechanics (Lab Course included)*	9 C 9 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit physikalischen Zusammenhängen und ihrer Anwendung im Experiment vertraut. Sie können... • die grundlegenden Begriffe und Methoden der klassischen Mechanik und Thermodynamik anwenden; • einfache physikalische Systeme modellieren und mit den erlernten mathematischen Techniken behandeln; • elementare Experimente zu Fragestellungen aus den in der zugehörigen Vorlesung besprochenen Bereichen der Physik durchführen, auswerten und kritisch interpretieren; insbesondere Erarbeitung von Grundlagen der Fehlerrechnung und schriftlicher Dokumentation der Messung und Messergebnisse; • die Grundlagen der guten wissenschaftlichen Praxis anwenden. • im Team experimentelle Aufgaben lösen; • fortgeschrittene Textverarbeitungsprogramme beherrschen und Programme zur Auswertung wissenschaftlicher Daten einsetzen.	**Arbeitsaufwand:** Präsenzzeit: 126 Stunden Selbststudium: 144 Stunden

Lehrveranstaltung: Vorlesung mit Übungen	6 SWS
Prüfung: Klausur (180 Minuten) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein sowie Anwesenheit bei mindestens der Hälfte der Übungstermine. **Prüfungsanforderungen:** Physikalische Größen (Dimensionen, Messfehler); Kinematik (Bezugsysteme, Bahnkurve); Dynamik (Newton’sche Gesetze, Bewegungsgleichungen, schwere und träge Masse); Erhaltungssätze für Energie; Impuls, und Drehimpuls; Stöße; Zentralkraftproblem; Schwingungen (harmonischer Oszillator, Resonanz); Beschleunigte Bezugsysteme und Trägheitskräfte; Starre Körper (Drehmoment, Trägheitsmoment, Steinersche Satz). Deformierbare Medien und Kontinuumsmechanik (Hooke'sche Gesetz, hydrostatisches Gleichgewicht, Bernoulli). Die drei Hauptsätze der Thermodynamik; Wärme, Energie, Entropie, Temperatur, und Druck; Zustandsgleichungen; Thermodynamische Gleichgewichte und Phasenübergänge; Kreisprozess; Ideale und reale Gase.	

Lehrveranstaltung: Praktikum zu Experimentalphysik I	3 SWS
Prüfung: 5 Protokolle (max. 15 Seiten), unbenotet **Prüfungsanforderungen:** Auswertung und Bewertung von physikalischen Experimenten sowie Interpretation der durchgeführten Experimente.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof.in Cynthia Ann Volkert Prof. Sarah Köster, Prof. Ansgar Reiners
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 1
Maximale Studierendenzahl: 210	

Georg-August-Universität Göttingen **Modul B.Phy.1102: Experimentalphysik II - Elektromagnetismus (mit Praktikum)** *English title: Experimental Physics II - Electromagnetism (Lab Course incl.)*	9 C 9 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit physikalischen Zusammenhängen und ihrer Anwendung im Experiment vertraut. Sie können... • die grundlegenden Begriffe und Methoden der Elektrostatik und -dynamik anwenden; • einfache Feldverteilungen modellieren und mit den erlernten mathematischen Techniken behandeln; • elementare Experimente zu Fragestellungen aus den in der zugehörigen Vorlesung besprochenen Bereichen der Physik durchführen, auswerten und kritisch interpretieren; insbesondere Erarbeitung von Grundlagen der Fehlerrechnung und schriftlicher Dokumentation der Messung und Messergebnisse; • die Grundlagen der guten wissenschaftlichen Praxis anwenden. • im Team experimentelle Aufgaben lösen.	**Arbeitsaufwand:** Präsenzzeit: 126 Stunden Selbststudium: 144 Stunden
Lehrveranstaltung: Experimentalphysik II - Elektromagnetismus	6 SWS
Prüfung: Klausur (180 Minuten) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Beherrschung und Anwendung der Grundbegriffe und Methoden der Elektrodynamik, insbesondere des Feldkonzeptes. Elektro- und Magnetostatik; Elektrisches Feld, Potential und Spannung; Vektoranalysis, Sätze von Gauß und Stokes; Elektrischer Strom und Widerstand, Stromkreise; Randwertprobleme und Multipolentwicklung; Biot-Savart'sches Gesetz; Dielektrische Polarisation und Magnetisierung; Induktion; Schwingkreise; Maxwell-Gleichungen; Elektromagnetische Potentiale; Teilchen in Feldern, Energie und Impuls; Elektromagnetische Wellen, beschleunigte Ladungen; Relativitätstheorie (relativistische Mechanik, Lorentzinvarianz der Elektrodynamik).	6 C
Lehrveranstaltung: Praktikum zu Experimentalphysik II	3 SWS
Prüfung: Protokoll (max. 15 Seiten) **Prüfungsvorleistungen:** 6 testierte schriftliche Versuchsprotokolle des Praktikumsteils. **Prüfungsanforderungen:** Kenntnisse in Auswertung und Bewertung von physikalischen Experimenten sowie Interpretation der durchgeführten Experimente.	3 C

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	Experimentalphysik I

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Angela Rizzi Prof. Jörg Enderlein, Prof. Tim Salditt; Prof. Hans Hofsäss
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 2
Maximale Studierendenzahl: 210	

Georg-August-Universität Göttingen **Modul B.Phy.1103: Experimentalphysik III - Wellen und Optik (mit Praktikum)** *English title: Experimental Physics III - Waves and Optics (Lab Course incl.)*	9 C 9 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit physikalischen Zusammenhängen und ihrer Anwendung im Experiment vertraut. Sie können... • die grundlegenden Begriffe und Methoden der Wellenausbreitung und Optik anwenden; • einfache Systeme mit Konzepten der geometrischen Optik und Wellenoptik modellieren und mit den erlernten mathematischen Techniken behandeln; • elementare Experimente zu Fragestellungen aus den in der zugehörigen Vorlesung besprochenen Bereichen der Physik durchführen, auswerten und kritisch interpretieren; insbesondere Erarbeitung von Grundlagen der Fehlerrechnung und schriftlicher Dokumentation der Messung und Messergebnisse; • die Grundlagen der guten wissenschaftlichen Praxis anwenden; • im Team experimentelle Aufgaben lösen.	**Arbeitsaufwand:** Präsenzzeit: 126 Stunden Selbststudium: 144 Stunden

Lehrveranstaltung: Vorlesung mit Übung	6 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Beherrschung der grundlegenden Begriffe, Fakten und Methoden aus dem Bereich Wellen und Optik. Wellenphänomene und Wellengleichungen (mechanische und elektromagnetische Wellen), Wellenleiter, Superpositionsprinzip, Dispersion, Absorption, Streuung, Phasen- und Gruppengeschwindigkeit, Fourier-Transformation, Huygen'sches Prinzip, Eikonalgleichung und Fermat'sches Prinzip, Geometrische Optik (Brechung, Linsen, optische Instrumente, Prisma, Wellenleiter geometrisch), Polarisation, Fresnelkoeffizienten (Reflexion, Transmission, Brewster-Winkel), Anisotrope Medien und Kristalloptik, Interferenz und Beugung (Fresnel-Kirchhoff-Integral, Fresnel- und Fraunhofer-Näherung), Auflösungsgrenze und Mikroskopie, Kohärenz, stimulierte Emission, Laserprinzip.	6 C

Lehrveranstaltung: Praktikum zu Experimentalphysik III	3 SWS
Prüfung: Protokoll (max. 15 Seiten) **Prüfungsvorleistungen:** 7 testierte schriftliche Versuchsprotokolle des Praktikumsteils. **Prüfungsanforderungen:** Kenntnisse in Auswertung und Bewertung von physikalischen Experimenten sowie Interpretation der durchgeführten Experimente.	3 C

Prüfungsanforderungen:	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Experimentalphysik II
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Claus Ropers Prof. Tim Salditt; Prof. Jörg Enderlein
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 3
Maximale Studierendenzahl: 180	

Georg-August-Universität Göttingen **Modul B.Phy.1104: Experimentalphysik IV - Atom- und Quantenphysik (mit Praktikum)** *English title: Experimental Physics IV - Atom and Quantum Physics (Lab Course incl.)*	9 C 9 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit physikalischen Zusammenhängen und ihrer Anwendung im Experiment vertraut. Sie können... • die grundlegenden Begriffe und Methoden der Quantenphysik anwenden; • einfache quantenmechanische Systeme (Atome, Moleküle, ...) modellieren und behandeln; • elementare Experimente zu Fragestellungen aus den in der zugehörigen Vorlesung besprochenen Bereichen der Physik durchführen, auswerten und kritisch interpretieren; insbesondere Erarbeitung von Grundlagen der Fehlerrechnung und schriftlicher Dokumentation der Messung und Messergebnisse; • die Grundlagen der guten wissenschaftlichen Praxis anwenden; • im Team experimentelle Aufgaben lösen.	**Arbeitsaufwand:** Präsenzzeit: 126 Stunden Selbststudium: 144 Stunden

Lehrveranstaltung: Vorlesung mit Übung	6 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Das Photon (thermische Strahlung, Photoeffekt, Compton-Effekt); Materiewellen, Schlüsselexperimente zur Quantentheorie und ihre Interpretation; Heisenberg’sche Unbestimmtheitsrelation; Wasserstoffatom (Bahn- und Spinmagnetismus, Feinstruktur und L-S Kopplung, Lamb Shift); Atome in elektrischen und magnetischen Feldern (Zeeman-, Paschen-Back-, und Stark-Effekt); Emission und Absorption; Spektren und Linienbreiten; Mehrelektronenatome; Grundlagen der chemischen Bindung; Molekülspektren (Rotations- und Vibrationsmoden); Laser.	6 C

Lehrveranstaltung: Praktikum zu Experimentalphysik IV	3 SWS
Prüfung: 7 testierte Protokolle (max. 15 Seiten), unbenotet **Prüfungsanforderungen:** Kenntnisse in Auswertung und Bewertung von physikalischen Experimenten sowie Interpretation der durchgeführten Experimente.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester

Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 4
Maximale Studierendenzahl: 180	

Georg-August-Universität Göttingen **Modul B.Phy.1201: Analytische Mechanik** *English title: Analytical mechanics*	8 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls können die Studierenden... • die Begriffe und Methoden der klassischen theoretischen Mechanik anwenden; • komplexe mechanische Systeme modellieren und mit den Erlernten formalen Techniken behandeln.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 156 Stunden
Lehrveranstaltung: Vorlesung mit Übung	
Prüfung: Klausur (180 Minuten) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Newton'sche Mechanik (Zentralkraftproblem, Streuquerschnitte); Lagrange-Formalismus (Variationsprinzipien, Nebenbedingungen und Zwangskräfte, Symmetrien und Erhaltungssätze); Starre Körper (Euler-Winkel, Trägheitstensor und Hauptachsentransformation, Euler-Gleichungen); Kleine Schwingungen; Hamilton-Formalismus (Legendre-Transformation, Phasenraum, Liouville'scher Satz, Poisson-Klammern).	8 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 2
Maximale Studierendenzahl: 180	

Georg-August-Universität Göttingen **Modul B.Phy.1202: Klassische Feldtheorie** *English title: Classical Field Theory*	8 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls • verfügen die Studierenden über ein vertieftes Verständnis der Begriffsbildungen der Feldtheorie; • besitzen die Studierenden erweiterte Fähigkeiten im Umgang mit den wichtigsten linearen und nichtlinearen partiellen Differentialgleichungen; • können Lösungsmethoden der Elektrostatik und der Elektrodynamik kennen und anwenden; • beherrschen die wichtigsten Anwendungsbeispiele.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 156 Stunden
Lehrveranstaltung: Vorlesung mit Übung	
Prüfung: Klausur (180 Minuten) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Konkrete Umsetzung der Methoden der Feldtheorie in einfachen Anwendungsbeispielen. Elementare Kontinuumsmechanik und Hydrodynamik; Elektromagnetische Felder und Maxwell'sche Gleichungen im Vakuum und in Materie; Quellen und Randbedingungen, Anfangswertproblem; Multipol-Entwicklung und elektromagnetische Strahlung; Lagrange-Formalismus der Feldtheorie; Spezielle Relativitätstheorie; Grundzüge der Allgemeinen Relativitätstheorie in der Sprache der Differentialgeometrie.	8 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Analytische Mechanik
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 3
Maximale Studierendenzahl: 180	

Georg-August-Universität Göttingen **Modul B.Phy.1203: Quantenmechanik I** *English title: Quantum Mechanics I*	8 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls können die Studierenden... • die Begriffe, Interpretation und mathematischen Methoden der Quantentheorie anwenden; • einfache Potentialprobleme mit den erlernten mathematischen Techniken behandeln.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 156 Stunden
Lehrveranstaltung: Vorlesung mit Übung	
Prüfung: Klausur (180 Minuten) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Kenntnis des konzeptionellen Rahmens, der Prinzipien und Methoden der Quantenmechanik: Wellenmechanik und Schrödinger-Gleichung. Statistische Interpretation von Quantensystemen; Eindimensionale Modellsysteme, gebundene Zustände und Streuzustände; Formulierung der Quantenmechanik (Hilbertraum, lineare Operatoren, unitäre Transformationen, Operatoren und Messgrößen, Symmetrie und Erhaltungsgrößen); Heisenberg-Bild; Quantisierung des Drehimpulses und Spin; Wasserstoffatom; Näherungsverfahren (Störungsrechnung, Variationsverfahren); Mehrteilchensysteme.	8 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 4
Maximale Studierendenzahl: 180	

Georg-August-Universität Göttingen **Modul B.Phy.1204: Statistische Physik** *English title: Statistical Physics*	8 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls können die Studierenden... • die Konzepte und Methoden der statistischen Physik anwenden; • einfache thermodynamische Systeme modellieren und mit den erlernten mathematischen Techniken behandeln.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 156 Stunden
Lehrveranstaltung: Vorlesung mit Übung	
Prüfung: Klausur (180 Minuten) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein.	8 C
Prüfungsanforderungen: Thermodynamik (Hauptsätze, Potentiale, Gleichgewichtsbedingungen, Phasenübergänge); Statistik (Wahrscheinlichkeitsverteilungen, Zentralwertsatz); Statistische Ensembles; Ergodenhypothese; Statistische Deutung der Thermodynamik; Zustandssumme; Theorie der Phasenübergänge; Quantenstatistik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5
Maximale Studierendenzahl: 180	

Georg-August-Universität Göttingen **Modul B.Phy.1301: Rechenmethoden der Physik** *English title: Mathematical Methods in Physics*	6 C 8 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollen die Studierenden... • sicher mit dem Mathematikstoff der Oberstufe umgehen können; • die für die Anwendungen im Grundstudium Physik notwendigen mathematischen Konzepte und Methoden beherrschen.	**Arbeitsaufwand:** Präsenzzeit: 112 Stunden Selbststudium: 68 Stunden
Lehrveranstaltung: Vorlesung	4 SWS
Prüfung: Bearbeitung von Übungszetteln (ca. 6 Zettel) und Klausur (120 Min.), unbenotet **Prüfungsvorleistungen:** Keine	6 C
Lehrveranstaltung: Übung	2 SWS
Lehrveranstaltung: Saalpraktikum	2 SWS
Prüfungsanforderungen: Kenntnis und Beherrschung von elementaren transzendenten Funktionen, komplexe Zahlen und komplexe Exponentialfunktion; Differentiation in einer und mehreren Veränderlichen, Integration; Folgen und Reihen; Taylor-Approximation von Funktionen; Vektoren und Produkte von Vektoren, lineare Abbildungen, Determinanten und Eigenwerte, Rechnen mit Matrizen, orthogonale Matrizen; Elemente der Vektoranalysis inkl. Integralsätze; Lösungsverfahren für gewöhnliche Differentialgleichungen n-ter Ordnung, lineare Systeme von Differentialgleichungen und einfache partielle Differentialgleichungen. Die Bearbeitung der Übungszettel dient der Festigung des Lehrstoffs und der Vorbereitung auf die Klausur.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 1

Georg-August-Universität Göttingen **Modul B.Phy.1410: Zertifizierungsmodul Astro-/Geophysik** *English title: Certificate study focus Astrophysics/Geophysics*	4 C

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls haben die Studierenden ihr Wissen im Bereich der Astro-/Geophysik (veranstaltungsübergreifend) vertieft. Die Studierenden sollten... • sich ein größeres Gebiet der Astro-/Geophysik selbstständig erarbeitet haben; • die Bachelorarbeit in einem breiten Kontext als Seminarvortrag wissenschaftlich darstellen können • Grundlagen der Astro-/Geophysik im Gespräch darstellen und anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 0 Stunden Selbststudium: 120 Stunden

Prüfung: Vortrag (ca. 45 Min.) und mdl. Prüfung (ca. 45 Min.) **Prüfungsanforderungen:** Vortrag über die eigene Bachelorarbeit sowie mdl. Prüfung zum gewählten Schwerpunkt (Astro- bzw. Geophysik); Beherrschung und Anwendung der Begriffe und Methoden der Astro- bzw. Geophysik (Niveau Bachelor).	4 C

Zugangsvoraussetzungen: 1.) Einführung in die Astro- bzw. Geophysik 2.) Vertiefende Veranstaltung in Astro- bzw. Geophysik 3.) Einführung ins wissenschaftliche Arbeiten: Astro- bzw. Geophysik 4.) Bachelorarbeit angemeldet in Astro- bzw. Geophysik	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: 210	

Georg-August-Universität Göttingen **Modul B.Phy.1411: Zertifizierungsmodul Biophysik/Physik komplexer Systeme** *English title: Certificate study focus in Biophysics/Physics of Complex Systems*	4 C
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls haben die Studierenden ihr Wissen im Bereich der Biophysik/Physik komplexer Systeme (veranstaltungsübergreifend) vertieft. Die Studierenden sollten... • sich ein größeres Gebiet der Biophysik/komplexer Systeme selbstständig erarbeitet haben; • die Bachelorarbeit in einem breiten Kontext als Seminarvortrag wissenschaftlich darstellen können • Grundlagen der Biophysik/komplexer Systeme im Gespräch darstellen und anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 0 Stunden Selbststudium: 120 Stunden
Prüfung: Vortrag (ca. 45 Min.) und mdl. Prüfung (ca. 45 Min.) **Prüfungsanforderungen:** Vortrag über die eigene Bachelorarbeit sowie ca. 45 Min. mdl. Prüfung zur Biophysik bzw. Physik komplexer Systeme; Beherrschung und Anwendung der Begriffe und Methoden in Biophysik bzw. Physik komplexer Systeme (Niveau Bachelor).	4 C

Zugangsvoraussetzungen: 1.) Einführende Veranstaltung in Biophysik bzw. Physik komplexer Systeme 2.) Vertiefende Veranstaltung in Biophysik bzw. Physik komplexer Systeme 3.) Einführung ins wissenschaftliche Arbeiten: Biophysik bzw. Physik komplexer Systeme 4.) Bachelorarbeit angemeldet in Biophysik bzw. Physik komplexer Systeme	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: 210	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.Phy.1412: Zertifizierungsmodul Festkörper-/Materialphysik
English title: Certificate study focus Solid State Physics / Materials Physics</td><td>4 C</td></tr>
<tr><td>Lernziele/Kompetenzen:
Nach erfolgreichem Absolvieren des Moduls haben die Studierenden ihr Wissen im Bereich der Festkörper-/Materialphysik (veranstaltungsübergreifend) vertieft. Die Studierenden sollten...
• sich ein größeres Gebiet der Festkörper-/Materialphysik selbstständig erarbeitet haben;
• die Bachelorarbeit in einem breiten Kontext als Seminarvortrag wissenschaftlich darstellen können
• Grundlagen der Festkörper-/Materialphysik im Gespräch darstellen und anwenden können.</td><td>Arbeitsaufwand:
Präsenzzeit:
0 Stunden
Selbststudium:
120 Stunden</td></tr>
<tr><td>Prüfung: Vortrag (ca. 45 Min.) und mdl. Prüfung (ca. 45 Min.)
Prüfungsanforderungen:
Vortrag über die eigene Bachelorarbeit sowie mdl. Prüfung in Festkörper- bzw. Materialphysik;
Beherrschung und Anwendung der Begriffe und Methoden in Festkörper- bzw. Materialphysik (Niveau Bachelor)</td><td>4 C</td></tr>
</table>

Zugangsvoraussetzungen: 1.) Einführende Veranstaltung in Festkörper- bzw. Materialphysik 2.) Vertiefende Veranstaltung in Festkörper- bzw. Materialphysik 3.) Einführung ins wissenschaftliche Arbeiten: Festkörper- bzw. Materialphysik 4.) Bachelorarbeit angemeldet in Festkörper- bzw. Materialphysik	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: 210	

Georg-August-Universität Göttingen **Modul B.Phy.1413: Zertifizierungsmodul Kern-/Teilchenphysik** *English title: Certificate study focus particle physics*	4 C

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls haben die Studierenden ihr Wissen im Bereich der Kern-/Teilchenphysik (veranstaltungsübergreifend) vertieft. Die Studierenden sollten... • sich ein größeres Gebiet der Kern-/Teilchenphysik selbstständig erarbeitet haben; • die Bachelorarbeit in einem breiten Kontext als Seminarvortrag wissenschaftlich darstellen können • Grundlagen der Kern-/Teilchenphysik im Gespräch darstellen und anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 0 Stunden Selbststudium: 120 Stunden

Prüfung: Vortrag (ca. 45 Min.) und mdl. Prüfung (ca. 45 Min.) **Prüfungsanforderungen:** Vortrag (ca. 45 Min.) über die eigene Bachelorarbeit sowie ca. 45 Min. mdl. Prüfung in Kern-/Teilchenphysik; Beherrschung und Anwendung der Begriffe und Methoden der KT	4 C

Zugangsvoraussetzungen: 1.) Einführung in KT 2.) Teilchenpyhsik II 3.) Einführung ins wissenschaftliche Arbeiten: KT 4.) Bachelorarbeit angemeldet in KT	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: 210	

Georg-August-Universität Göttingen **Modul B.Phy.1511: Einführung in die Kern- und Teilchenphysik** *English title: Introduction to Particle Physics*	8 C 6 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls kennen die Studierenden physikalische Fakten und Modellvorstellungen über den Aufbau der Atomkerne und die Eigenschaften von Elementarteilchen. Außerdem sollten sie mit den grundlegenden Begriffen und Modellen der Kern- und Teilchenphysik umgehen können.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 156 Stunden

Lehrveranstaltung: Einführung in die Kern- und Teilchenphysik	
Prüfung: Klausur (120 Min.) oder mdl. Prüfung (ca. 30 Min.) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein.	8 C

Prüfungsanforderungen: Eigenschaften und Spektroskopie von stabilen und instabilen Atomkernen; Eigenschaften von Elementarteilchen und Experimente der Hochenergiephysik; Grundlagen der Teilchenbeschleunigerphysik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 180	

Georg-August-Universität Göttingen **Module B.Phy.1512: Particle physics II - of and with quarks**	6 C 6 WLH

Learning outcome, core skills: After successful completion of this module, students should be familiar with the properties and interactions of quarks as well as with experimental methods and experiments which lead to their discovery and are used for precise studies.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Particle physics II - of and with quarks (Lecture)	4 WLH
Course: Particle physics II - of and with quarks (Exercise)	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Concepts and methods along with specific implementations of statistical methods in data analysis. Properties and discovery of quarks, discovery of W and Z bosons at hadron colliders, the top-quark, CKM mixing matrix, decays of heavy quarks, quark mixing and oscillations, CP-violation, jets, gluons and fragmentation, deep-inelastic scattering, QCD tests and measurement of the strong coupling alpha_s.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.1521: Einführung in die Festkörperphysik** *English title: Introduction to Solid State Physics*	8 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls haben die Studierenden die Grundlagen und die physikalische Erscheinungen der Zusammenhalt der Ionen und Elektronen in einem Festkörper mit idealen periodischen Anordnung der konstituierenden Atomen verinnerlicht. Basierend auf der Eigenschaften freier Atomen und deren Wechselwirkung im Kristallgitter wird ein grundlegendes Verständnis verschiedener kollektiven Phänomene gewonnen. Dazu gehören beispielsweise die elektronische Bandstruktur im periodischen Gitterpotential (Dynamik der Elektronen) sowie die Gitterschwingungen (Dynamik der Ionen), die Elektrizitätsleitung - auch in niederdimensionalen Strukturen - sowie thermische Eigenschaften (spezifische Wärme).	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 156 Stunden
Lehrveranstaltung: Vorlesung und Übung Einführung in die Festkörperphysik	
Prüfung: Klausur (120 min.) oder mdl. Prüfung (ca. 30 min.) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Grundlagen, Phänomene und Modelle für Elektronen- und Gitterdynamik in Festkörpern. Insbesondere, Chemische Bindung in Festkörpern, Atomare Kristallstruktur, Streuung an periodischen Strukturen, das Elektronengas ohne Wechselwirkung (Freie Elektronen), das Elektronengas mit Wechselwirkung (Abschirmung, Plasmonen), das periodische Potential (Bandstrukturd der Kristall-Elektronen), Gitterschwingungen (Phononen) und spezifische Wärme	8 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Angela Rizzi
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 120	

Georg-August-Universität Göttingen **Module B.Phy.1522: Solid State Physics II**	6 C 4 WLH

Learning outcome, core skills: After successful completion of this Module students will be able to understand: • The role of the band-structure for electron and lattice dynamics • The motion of crystal electrons/holes in electric and magnetic fields • Quasiparticle scattering processes • The deviation of macroscopic dielectric properties from microscopic theory • The dielectric properties of metals and plasma oscillations • Independent electron magnetism and the emergence of collective magnetic phenomena • Magnetic ordering phenomena • The BCS theory of superconductivity	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Solid State Physics II	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Examination topics: Basics, phenomena and models for electrons and lattice dynamics in solids. Concepts of quasi-particle interaction: Transport phenomena incl. electrical and thermal conductivity, dielectric properties, plasmons. Semiconductors, magnetic properties of solids, superconductivity.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics
Language: German, English	**Person responsible for module:** Prof. Dr. Stefan Dirk Mathias
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 120	

Georg-August-Universität Göttingen **Module B.Phy.1531: Introduction to Materials Physics**	4 C 4 WLH
Learning outcome, core skills: This 2 week long intensive course is offered between the winter and summer semesters. It applies the knowledge obtained in the Einführung in die Festkörperphysik and Thermodynamik und statistische Physik to understanding the structure, properties and dynamic behavior of the materials we use in our everyday lives. **Learning outcomes:** crystal defects, disordered systems, impurities, crystalline mixtures and alloys, phase diagrams, phase transformations, diffusion, kinetics, materials selection, structure-property relations. **Core skills:** The students will gain an understanding of the different materials classes that we use in everyday life, including: how properties of materials are determined by their atomic scale structure, which driving forces determine the structure of equilibrium phases, and how kinetic processes control phase transformations and the dynamics of non-equilibrium processes.	**Workload:** Attendance time: 56 h Self-study time: 64 h
Course: Introduction to Materials Physics (Lecture)	2 WLH
Examination: Written or oral examWritten exam (120 minutes) or oral examination (approximately 30 minutes) **Examination prerequisites:** 50% of the homework problems must be solved successfully. **Examination requirements:** Crystal defects, disordered systems, impurities, crystalline mixtures and alloys, phase diagrams, phase transformations, diffusion, kinetics, materials selection.	4 C
Course: Introduction to Materials Physics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** • Experimentelle Methoden der Materialphysik, • Einführung in die Festkörperphysik, • Thermodynamik und statistische Physik
Language: English	**Person responsible for module:** Prof.in Cynthia Ann Volkert
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.1532: Experimentelle Methoden der Materialphysik** *English title: Experimental Methods for Materials Science*	6 C 4 SWS
Lernziele/Kompetenzen: **Lernziele:** Erlernen der verschiedenen experimentellen Verfahren zur Herstellung von Materialien (mit Schwerpunkt auf dünnen Schichten) und Methoden zur Untersuchung ihrer strukturellen Eigenschaften sowie Basiswissen zum Einsatz solcher Methoden. **Kompetenzen:** Die Studierenden sollen ein vertiefendes Verständnis zur Herstellung von Materialien und zur Untersuchung ihrer strukturellen Eigenschaften erlangen sowie Erfahrungen mit einigen dieser Methoden gewinnen	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vorlesung Experimentelle Methoden	1 SWS
Lehrveranstaltung: Seminar Experimentelle Methoden	1 SWS
Lehrveranstaltung: Praktikum Experimentelle Methoden	2 SWS
Prüfung: Präsentation (ca. 30 min.) und 2 Protokolle (je max. 7 S. exklusive Bilder) **Prüfungsvorleistungen:** keine **Prüfungsanforderungen:** Vertiefendes Verständnis der zugrundeliegenden physikalischen Prinzipien und der praktischen Realisierung von experimentellen Methoden der Materialphysik. Atomare Bindung und Kristallstruktur, Kristallographie (Symmetrien), Grundlagen in Defekte, Thermodynamik von Phasen und Mischungen, Ordnungseffekte, Phasengleichgewichte, Phasendiagramme, Überblick über Materialeigenschaften, Grundlagen Materialauswahl. Die Benotung setzt sich aus der Präsentation (50%) und den Protokollen (50%) zusammen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Phy.1531 Einführung in die Materialphysik
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof.in Cynthia Ann Volkert
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 6
Maximale Studierendenzahl: 24	

Georg-August-Universität Göttingen **Modul B.Phy.1541: Einführung in die Geophysik** *English title: Introduction to Geophysics*	4 C 3 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls können die Studierenden mit den grundlegenden Begriffen und Modellen der Geophysik umgehen: • Treibhauseffekt • Gravimetrie • Seismologie • Elektromagnetische Tiefenforschung • Altersbestimmung • Gezeiten • Konvektion • Erdmagnetfeld • Fraktale und chaotische Prozesse • Plattentektonik	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 78 Stunden
Lehrveranstaltung: Vorlesung und Übung zu Einführung in die Geophysik	
Prüfung: Klausur (120 min.) oder mdl. Prüfung (ca. 30 min.) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Grundlagen der Geophysik, insbes. Plattentektonik, Erdbeben	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Tilgner
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 2
Maximale Studierendenzahl: 120	

Georg-August-Universität Göttingen Module B.Phy.1551: Introduction to Astrophysics	8 C 6 WLH
Learning outcome, core skills: After successful completion of the module students are familiar with the basic concepts of astrophysics in observation and theory. In particular, they • have gained an overview of observational techniques in astronomy • understand the basic physics of the formation, structure and evolution of stars and planets have learned about the classification and structure of normal and active galaxies • understand the basic physics of homogeneous cosmology and cosmological structure formation	**Workload:** Attendance time: 84 h Self-study time: 156 h
Course: Lecture and exercises for introduction to astrophysics	
Examination: oral (approx. 30 minutes) or written (120 min.) exam **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully. **Examination requirements:** Observational techniques, Planets and exoplanets, planet formation, stellar formation, structure and evolution, galaxies, AGN and quasars, cosmology, structure formation	8 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Jens Carsten Niemeyer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1
Maximum number of students: 120	

Georg-August-Universität Göttingen **Module B.Phy.1561: Introduction to Physics of Complex Systems**	6 C 6 WLH
Learning outcome, core skills: Sound knowledge of essential methods and concepts from Nonlinear Dynamics and Complex Systems Theory, including practical skills for analysis and simulation (using, for example, the programming language python) of dynamical systems.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Introduction to Physics of Complex Systems (Lecture)	4 WLH
Examination: written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully. **Examination requirements:** • Knowledge of fundamental principles and methods of Nonlinear Physics • Modern experimental techniques and theoretical models of Complex Systems theory.	6 C
Course: Introduction to Physics of Complex Systems (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic programming skills (for the exercises)
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp Prof. Dr. Ulrich Parlitz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 2
Maximum number of students: 120	

Georg-August-Universität Göttingen **Module B.Phy.1571: Introduction to Biophysics**	6 C 6 WLH

Learning outcome, core skills: After attending this course, students will have basic knowledge about • the build-up of cells and the function of the components • transport phenomena on small length scales, derivation and solution of the diffusion equation • laminar hydrodynamics and its application in biological systems (flow, swimming, motility) • reaction kinetics and cooperativity, including enzymes • non-covalent interaction forces • self-assembly • biological (lipid) membrane build-up and dynamics • biopolymer physics and cytoskeletal filaments, including filament and cell mechanics • neurobiophysics • experimental methods, including state-of-the-art microscopy	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Introduction to Biophysics (Lecture) *Contents*: components of the cell; diffusion, Brownian motion and random walks; low Reynolds number hydrodynamics; chemical reactions, cooperativity and enzymes; biomolecular interaction forces and self-assembly; membranes; polymer physics and mechanics of the cytoskeleton; neurobiophysics; experimental methods and microscopy	4 WLH
Examination: Written exam (120 min.) or oral exam (ca. 30 min.) **Examination prerequisites:** At least 50% of the homework problems have to be solved successfully. **Examination requirements:** Knowledge of the fundamental principles, theoretical descriptions and experimental methods of biophysics.	6 C

Course: Introduction to Biophysics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 2
Maximum number of students: 100	

Georg-August-Universität Göttingen **Modul B.Phy.1601: Grundlagen der C-Programmierung** *English title: Basics of C programming*	6 C 3 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen eine aktuelle Programmiersprache, sie • beherrschen den Einsatz von Editor, Compiler und weiteren Programmierwerkzeugen (z.B. Build-Management-Tools). • kennen grundlegende Techniken des Programmentwurfs und können diese anwenden. • kennen Standarddatentypen (z.B. für ganze Zahlen und Zeichen) und spezielle Datentypen (z.B. Felder und Strukturen). • kennen die Operatoren der Sprache und können damit gültige Ausdrücke bilden und verwenden. • kennen die Anweisungen zur Steuerung des Programmablaufs (z.B. Verzweigungen und Schleifen) und können diese anwenden. • kennen die Möglichkeiten zur Strukturierung von Programmen (z.B. Funktionen und Module) und können diese einsetzen. • kennen die Techniken zur Speicherverwaltung und können diese verwenden. • kennen die Möglichkeiten und Grenzen der Rechnerarithmetik (z.B. Ganzzahl- und • Gleitkommarithmetik) und können diese beim Programmentwurf berücksichtigen. • kennen die Programmbibliotheken und können diese einsetzen.	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

Lehrveranstaltung: Kompaktkurs Grundlagen der C-Programmierung *Angebotshäufigkeit:* jedes Wintersemester	
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Standarddatentypen, Konstanten, Variablen, Operatoren, Ausdrücke, Anweisungen, Kontrollstrukturen zur Steuerung des Programmablaufs, Strings, Felder, Strukturen, Zeiger, Funktionen, Speicherverwaltung, Rechnerarithmetik, Ein-/Ausgabe, Module, Standardbibliothek, Präprozessor, Compiler, Linker	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jährlich	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 1

Georg-August-Universität Göttingen **Modul B.Phy.1602: Computergestütztes wissenschaftliches Rechnen** *English title: Scientific Computing*	6 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren können die Studierenden komplexe Probleme aus dem naturwissenschaftlichen Bereich in effiziente Algorithmen umsetzen. Weiter sind sie in der Lage, diese Algorithmen in Programme oder Programmbibliotheken zu fassen, die durch gute Programmierpraxis (Dokumentation, Modularisierung und Versionsverwaltung) lange effizient wartbar und nutzbar bleibt. Einfache Parallelisierungsstrategien können zur effizienten Implementierung angewendet werden. Die Studierenden sind in der Lage gewonnene numerische Daten auszuwerten, zu interpretieren, grafisch aufzubereiten und in guter wissenschaftlicher Form zu präsentieren.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Computergestütztes wissenschaftliches Rechnen (Vorlesung, Übung)	
Prüfung: Schriftlicher Bericht (max. 10 Seiten) **Prüfungsvorleistungen:** 4 erfolgreich bearbeitete Programmieraufgaben **Prüfungsanforderungen:** Umsetzung einer Aufgabenstellung in ein lauffähiges, effizientes Programm. Anschließende wissenschaftliche Interpretation der Ergebnisse.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse der Programmiersprache C
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Stefan Klumpp
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 4
Maximale Studierendenzahl: 200	

Georg-August-Universität Göttingen **Modul B.Phy.1603: Vermittlung wissenschaftlicher Zusammenhänge durch neue Medien** *English title: Procurement of scientific phenomena via new media*	4 C 2 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
In dieser Veranstaltung werden Grundkonzepte und Regeln des Videofilmens physikalischer/naturwissenschaftlicher Phänomene vermittelt, treatments erstellt, und das Drehen von Filmen handwerklich geübt. Physikalische Phänomene z.B. aus der Physik-Show "Zauberhafte Physik" werden gefilmt und in Kombination mit Archivmaterial zu kurzen Video-Clips zusammengeschnitten. Dabei wird unter anderem ein Schwerpunkt auf die allgemeinverständliche physikalische Erklärung (Pädagogik) gelegt. Es wurden aber auch formale Aspekte im Umgang mit Medien wie Copyrights, GEMA-Gebühren, Rechte am eigenen Bild etc. vermittelt. Die Video-Clips werden nach Abnahme durch die Seminarleitung und die Presseabteilung in den offiziellen Youtube-Kanal der Georg-August-Universität Göttingen gestellt. Beispiele aus vergangenen Semester sind unter „Zauberhafte Physik“ auf http://www.youtube.de zu finden.	Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Seminar (Seminar)	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** Aktive Teilnahme **Prüfungsanforderungen:** Physikalische/wissenschaftliche Zusammenhänge allgemeinverständlich und unterstützt durch den Einsatz von selbstgedrehten Videofilmen erklären zu können.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Arnulf Quadt
Angebotshäufigkeit: jedes Wintersemester1	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 5 - 6; Master: 1 - 4
Maximale Studierendenzahl: 16	

Georg-August-Universität Göttingen **Modul B.Phy.1604: Projektpraktikum** *English title: Project Course*	6 C 6 SWS

Lernziele/Kompetenzen: Diese Veranstaltung gibt Studierenden die Möglichkeit, grundlegende Schritte eines wissenschaftlichen Projekts kennen zu lernen. In kleinen Gruppen von zwei bis sechs Studierenden werden eigene, überschaubare Versuche zu einem frei wählbaren Thema zunächst konzipiert, aufgebaut und ausgewertet. Die gewonnenen Ergebnisse werden sowohl schriftlich dokumentiert wie auch mündlich präsentiert. Nach erfolgreichem Abschluss des Moduls können die Studierenden komplexe experimentelle Fragestellungen als Projekt in Teamarbeit planen, durchführen, dokumentieren, aus- und bewerten sowie präsentieren.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Projektpraktikum (Praktikum)	
Prüfung: Präsentation (ca. 30 Min.; 20 %) und schriftliche Zusammenfassung (max. 30 S.; 80%)	6 C

Prüfungsanforderungen: Planung, Durchführung, Dokumentation und Bewertung von Projekten in Teamarbeit	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Martin Wenderoth
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 4
Maximale Studierendenzahl: 200	

Georg-August-Universität Göttingen **Modul B.Phy.1605: Programmieren in Python** *English title: Programming in Python*	6 C 3 SWS
Lernziele/Kompetenzen: Die Studierenden erlernen Python. Sie lernen • verschiedene Programmierumgebungen kennen • die Grundstrukturen und -elemente der Programmiersprache Python • Datentypen, Strukturen und den effizienten Umgang mit ihnen • Verwendung von nützlichen Bibliotheken • Zugriff auf und Verarbeitung von Daten • Numerisches Lösen von Differentialgleichungen • Erstellen und Verwenden von Grafiken • ComputerVision- und dreidimensionale Darstellungen • Parallelisierung von Prozessen • Programmierung von Microcontrollern	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
Lehrveranstaltung: Programmieren in Python (Vorlesung mit Übung und Rechnerpraktikum)	3 SWS
Prüfung: Projektarbeit und mündliche Prüfung (ca. 20 min), unbenotet **Prüfungsvorleistungen:** Lösung von Programmieraufgaben **Prüfungsanforderungen:** Kenntnis der Syntax und Semantik der Programmiersprache, zielorientierter Einsatz von Bibliotheken und Methoden zur Datenanalyse und zur Visualisierung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Nobach
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 2 - 4
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Phy.1609: Grundlagen zur Einheit von Mensch und Natur** *English title: Foundations of the Unity of Human and Nature*	4 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten Studierende Einblicke in die naturwissenschaftlichen, ökonomischen und weltanschaulichen Grundlagen der Wechselbeziehung Mensch – Natur gewonnen haben. Sie sollten... • über Grundlagen in der Systemdynamik komplexer Systeme verfügen; • mit Präsentationsmedien umgehen können; • komplexe Sachverhalte vor Experten und fachfremden Zuhörern präsentieren können; • den Erkenntnisforschritt im Seminar kritisch reflektieren können. Als Schlüsselkompetenzen sollten sie Diskussionsfähigkeit, Kritikfähigkeit und Ausdrucksfähigkeit erworben haben.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Grundlagen zur Einheit von Mensch und Natur	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** Aktive Mitwirkung an der Diskussion der Präsentationen und Erarbeitung eines laufenden Erkenntnisfortschritt des Seminars als Hausaufgabe **Prüfungsanforderungen:** Verständnis der wissenschaftlichen Grundlagen der Wechselbeziehung Mensch-Natur anhand wissenschaftlicher Fachliteratur. Die Entwicklung des Stoffwechsels des Menschen mit der Natur, insbesondere in der Produktion und Reproduktion von Gütern behandelt und ihre philosophische Reflektion wird behandelt. Der Schwerpunkt liegt auf der modernen Entwicklung der internationalen kapitalistischen Produktion zu einem dominanten Einflussfaktor auf die Biosphäre, die daraus resultierenden Möglichkeiten und die Faktoren der möglichen Untergrabung der Einheit von Mensch und Natur in einer globalen Umweltkatastrophe.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.Phy.405: Einführung ins wissenschaftliche Arbeiten: Astro-/Geophysik** *English title: Introduction to scientific work: Astro-/Geophysics*	6 C
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden einfache Projekte im Bereich der Astro- und Geophysik vorbereiten, durchführen und schriftlich darstellen können. Sie sollten... • die Grundlagen des Umgangs mit Literatursuchsystemen beherrschen; • sich selbstständig in ein begrenztes wissenschaftliches Themengebiet einarbeiten können; • mit einem modernen Datenanalysesystem umgehen können; • Form und Inhalt einer wissenschaftlichen Arbeit kennen.	**Arbeitsaufwand:** Präsenzzeit: 0 Stunden Selbststudium: 180 Stunden
Lehrveranstaltung: Einführung ins wissenschaftliche Arbeiten: Astro-/Geophysik Block	
Prüfung: Schriftlicher Bericht (max. 10 S.)	6 C
Prüfungsanforderungen: Elementare Kenntnisse in der Vorbereitung wissenschaftlicher Forschungsprojekte, ihrer Durchführung und schriftlichen Darstellung im Bereich der Astro- und Geophysik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jens Carsten Niemeyer
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 180	
Bemerkungen: Block	

Georg-August-Universität Göttingen **Modul B.Phy.406: Einführung ins wissenschaftliche Arbeiten: Biophysik/Physik komplexer Systeme** *English title: Introduction to scientific work: Biophysics/Physics of Complex Systems*	6 C

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden einfache Projekte im Bereich der Biophysik/Physik komplexer Systeme vorbereiten, durchführen und schriftlich darstellen können. Sie sollten... • die Grundlagen des Umgangs mit Literatursuchsystemen beherrschen; • sich selbstständig in ein begrenztes wissenschaftliches Themengebiet einarbeiten können; • mit einem modernen Datenanalysesystem umgehen können; • Form und Inhalt einer wissenschaftlichen Arbeit kennen.	**Arbeitsaufwand:** Präsenzzeit: 0 Stunden Selbststudium: 180 Stunden

Lehrveranstaltung: Einführung ins wissenschaftliche Arbeiten: Biophysik/Physik komplexer Systeme	
Prüfung: Schriftlicher Bericht (max. 10 S.)	6 C

Prüfungsanforderungen: Elementare Kenntnisse in der Vorbereitung wissenschaftlicher Forschungsprojekte, ihrer Durchführung und schriftlichen Darstellung im Bereich Biophysik und der Physik komplexer Systeme.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Tim Salditt
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 180	

Georg-August-Universität Göttingen **Modul B.Phy.407: Einführung ins wissenschaftliche Arbeiten: Festkörper-/Materialphysik** *English title: Introduction to scientific work: Solid State/Materials Physics*	6 C
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden einfache Projekte im Bereich der Festkörper-/Materialphysik vorbereiten, durchführen und schriftlich darstellen können. Sie sollten... • die Grundlagen des Umgangs mit Literatursuchsystemen beherrschen; • sich selbstständig in ein begrenztes wissenschaftliches Themengebiet einarbeiten können; • mit einem modernen Datenanalysesystem umgehen können; • Form und Inhalt einer wissenschaftlichen Arbeit kennen.	**Arbeitsaufwand:** Präsenzzeit: 0 Stunden Selbststudium: 180 Stunden
Lehrveranstaltung: Einführung ins wissenschaftliche Arbeiten: Festkörper-/Materialphysik Block	
Prüfung: Schriftlicher Bericht (max. 10 S.)	6 C
Prüfungsanforderungen: Elementare Kenntnisse in der Vorbereitung wissenschaftlicher Forschungsprojekte, ihrer Durchführung und schriftlichen Darstellung im Bereich Festkörper- und Materialphysik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Stefan Dirk Mathias
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 180	

Bemerkungen: Block

Georg-August-Universität Göttingen **Modul B.Phy.408: Einführung ins wissenschaftliche Arbeiten: Kern-/ Teilchenphysik** *English title: Introduction to scientific work: Nuclear/Particle Physics*	6 C
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden einfache Projekte im Bereich der Kern-/Teilchenphysik vorbereiten, durchführen und schriftlich darstellen können. Sie sollten... • die Grundlagen des Umgangs mit Literatursuchsystemen beherrschen; • sich selbstständig in ein begrenztes wissenschaftliches Themengebiet einarbeiten können; • mit einem modernen Datenanalysesystem umgehen können; • Form und Inhalt einer wissenschaftlichen Arbeit kennen.	**Arbeitsaufwand:** Präsenzzeit: 0 Stunden Selbststudium: 180 Stunden
Lehrveranstaltung: Einführung ins wissenschaftliche Arbeiten: Kern-/ Teilchenphysik Block	
Prüfung: Schriftlicher Bericht (max. 10 S.)	6 C
Prüfungsanforderungen: Elementare Kenntnisse in der Vorbereitung wissenschaftlicher Forschungsprojekte, ihrer Durchführung und schriftlichen Darstellung im Bereich der Kern- und Teilchenphysik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Arnulf Quadt
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 180	

Bemerkungen: Block

Georg-August-Universität Göttingen **Modul B.Phy.5001: Die Vermittlung und Untersuchung von strömungsphysikalischen Vorgängen im Experiment Teil I** *English title: Teaching and analysis of flow dynamic processes in physical experiments Part I*	6 C 4 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • die strömungsphysikalischen Grundlagen beherrschen und Messverfahren zur Strömungsvisualisierung an Beispielen anwenden können; • die Strömungsphysikalischen Phänomene anhand von Experimenten vorstellen und erklären können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vorlesung (Vorlesung)	2 SWS
Prüfung: 80 % mündliche Prüfung (ca. 30 Min.) + 20 % Praktische Prüfung (Experiment) (ca. 30 Min.)	6 C
Lehrveranstaltung: Übung	2 SWS
Prüfungsanforderungen: Auftrieb; Bernoulli-Gleichung; Energiebetrachtung von Strömungsvorgängen; Wirbelablösung; Kontinuitätsgleichung; Wirbelbildung/Entstehung in Abhängigkeit von der Reynoldszahl; Messverfahren zur Visualisierung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. nat. Oliver Boguhn
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Phy.5002: Die Vermittlung und Untersuchung von strömungsphysikalischen Vorgängen im Experiment Teil II** *English title: Teaching and analysis of flow dynamic processes in physical experiments Part II*	6 C 4 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • die theoretischen Grundlagen praxisbezogen anwenden und strömungsphysikalische Gesetzmäßigkeiten in Experimenten verifizieren können; • die strömungsphysikalischen Phänomene anhand von Experimenten vorstellen und erklären können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vorlesung (Vorlesung)	2 SWS
Prüfung: mündliche Prüfung (ca. 30 Min.) + Praktische Prüfung (Experiment) (ca. 30 Min.)	6 C
Lehrveranstaltung: Übung	2 SWS
Prüfungsanforderungen: Wirbelbildung/Entstehung in Abhängigkeit von der Reynoldszahl, Schwingungs- und Flatteranalyse, Schallentstehung, Ausbreitung, Quellenund Entfernungsabhängigkeiten, Strömungsvorgänge unter Schwerelosigkeit, Strahlungsinduzierte Strömungsvorgänge, Einfluss der Corioliskraft auf großräumige Strömungen	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. nat. Oliver Boguhn
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Phy.5004: Historische Objekte aus physikalischen Sammlungen** *English title: Historical objects from the physics collections*	4 C 2 SWS

Lernziele/Kompetenzen: Nach der erfolgreichen Teilnahme an der Modulveranstaltung sind die Studierende in der Lage • die physikalischen Grundlagen und Funktion von historischen Instrumenten zu erklären und mit geeigneten Methoden im Team zu präsentieren. • Prozesse der Erkenntnisgewinnung mit historischen Objekten und modernen Instrumenten zu vergleichen und zu bewerten. • Selbständig mit historischen Quellen zu arbeiten. • die Bedeutung historischer Sammlungen zu erkennen. • mit Datenbanken für historische Objekt zu arbeiten und sie als Informationsmedium zu nutzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Physikalische Grundlagen historischer Objekte aus den physikalischen Sammlungen (Seminar)	
Prüfung: Präsentation (ca. 30 Min.) mit schriftlicher Ausarbeitung (Template, max. 10 Seiten) **Prüfungsvorleistungen:** Regelmäßige Teilnahme **Prüfungsanforderungen:** Physikalische Grundlagen des Instruments, Einordnung in den historischen und gesellschaftlichen Kontext, Erkenntnisgewinnung, experimentelle und technische Weiterentwicklung, Klassifizierung des Objekts in einer Datenbank für historische Objekte	4 C

Prüfungsanforderungen: Aufarbeitung und Darstellung eines Gerätes der historischen Sammlung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** apl. Prof. Dr. Susanne Schneider
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 3
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module B.Phy.5402: Advanced Quantum Mechanics**	6 C 6 WLH
Learning outcome, core skills: **Acquisition of knowledge:** After successful completion of the module students will be familiar with the core concepts and mathematical methods of advanced quantum mechanics and quantum many-body theory. **Competencies:** Students will be able to model and analyse single-particle and many-body quantum mechanical systems, drawing also on concepts of quantum information theory.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Advanced Quantum Mechanics (Lecture)	4 WLH
Examination: written exam (120 min.) or oral exam (approx. 30 min.) **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully. **Examination requirements:** Time-dependent perturbation theory, scattering, mixed states, path integrals in quantum mechanics, quantum information, entanglement as resource, many-body systems, second quantisation, basis elements of quantum field theory.	6 C
Course: Advanced Quantum Mechanics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of 1-particle quantum mechanics
Language: English	**Person responsible for module:** Prof. Dr. Stefan Kehrein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 3
Maximum number of students: 80	

Georg-August-Universität Göttingen **Module B.Phy.5403: Fluctuation theorems, stochastic thermodynamics and molecular machines**	3 C 3 WLH

Learning outcome, core skills: After successful completion of the module students will be familiar with the core concepts and mathematical methods of stochastic thermodynamics, the key fluctuation theorems and applications to simple systems. Students will be able to model and analyse strongly fluctuating non-equilibrium processes within the framework of stochastic thermodynamics, in particular in the context of open reaction networks and simple discrete state models of molecular machines.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Fluctuation theorems, stochastic thermodynamics and molecular machines (lecture with exercise if necessary)	
Examination: oral (approx. 30 min.) or written exam (120 min.) **Examination requirements:** Stochastic dynamics (Markov chains), time reversal symmetry, integral and detailed fluctuation theorems, Langevin dynamics, applications to non-equilibrium dynamics of discrete state space models.	3 C

Admission requirements: none	**Recommended previous knowledge:** Module „Statistical mechanics and thermodynamics“ or equivalent knowledge of equilibrium statistical mechanics.
Language: English	**Person responsible for module:** Prof. Dr. Peter Kurt Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 80	

Georg-August-Universität Göttingen Module B.Phy.5404: Introduction to Statistical Machine Learning	3 C 3 WLH
Learning outcome, core skills: After successful completion of the module students will be familiar with the core concepts and mathematical methods of statistical machine learning. Students will be able to devise, implement and analyse a range of machine learning approaches based primarily on a Bayesian statistics framework, including methods for regression, classification and approximate inference methods based on connections to statistical physics.	**Workload:** Attendance time: 42 h Self-study time: 48 h
Course: Introduction to Statistical Machine Learning (lecture with exercise if necessary)	
Examination: oral (approx. 30 min.) or written exam (120 min.) **Examination requirements:** Bayesian regression and classification, non-parametric models including Gaussian process, graphical models, variational inference	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic probability theory and linear algebra; familiarity with equilibrium statistical mechanics is helpful
Language: English	**Person responsible for module:** Prof. Dr. Peter Kurt Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 80	

Georg-August-Universität Göttingen Module B.Phy.5405: Active Matter	3 C 2 WLH
Learning outcome, core skills: **Learning objectives**: The students will learn about the basic principles of the physics of active matter as characterized via nonequilibrium statistical physics. Topics will include: physics of micro-swimming, hydrodynamic coordination, continuum description of scalar active matter and motility-induced phase separation, polar active matter and flocking, active liquid crystals (e.g. nematics) and defects, phoretic active matter, activity in enzyme suspensions, and active membranes. **Competences**: This course will give the students a good theoretical understanding of active matter and enable them to follow the state-of-the-art research in the area of active matter.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Active Matter (Lecture)	
Examination: written examination (60 Min.) or oral examination (approx. 30 Min.)	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in statistical physics and hydrodynamics
Language: English	**Person responsible for module:** Prof. Dr. Ramin Golestanian
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5406: Physics with fluctuating paths: stochastic and trajectory thermodynamics**	3 C 3 WLH

Learning outcome, core skills: After successful completion of the module students will be familiar with the core concepts and mathematical methods of stochastic and trajectory thermodynamics including the key fluctuation theorems, statistics of path-based observables and dynamical phase transitions Students will be able to model and analyse strongly fluctuating non-equilibrium processes within the framework of stochastic and trajectory thermodynamics, with applications e.g. in driven systems, non-equilibrium dynamics and reaction networks.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Physics with fluctuating paths: stochastic and trajectory thermodynamics	2 WLH
Course: Physics with fluctuating paths: stochastic and trajectory thermodynamics	1 WLH
Examination: Mdl. Prüfung (ca. 30 Minuten) oder Klausur (120 Minuten) **Examination requirements:** Stochastic dynamics (Markov chains) and Langevin dynamics, entropy production and work, time reversal symmetry and fluctuation theorems, trajectory thermodynamics and large deviations, dynamical phase transitions	3 C

Admission requirements: none	**Recommended previous knowledge:** Module "Statistical mechanics and thermodynamics" or equivalent knowledge of equilibrium statistical mechanics.
Language: German, English	**Person responsible for module:** Prof. Dr. Peter Kurt Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 80	

Georg-August-Universität Göttingen **Modul B.Phy.5501: Aerodynamik** *English title: Aerodynamics*	6 C 4 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit den physikalischen Grundlagen der Aerodynamik vertraut und sollten diese auf elementare aerodynamische Zusammenhänge anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vorlesung Aerodynamik I (Vorlesung)	2 SWS
Lehrveranstaltung: Vorlesung Aerodynamik II (Vorlesung)	2 SWS
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	6 C
Prüfung: Mündlich (ca. 30 Minuten)	6 C
Prüfungsanforderungen: Kontinuumsphysikalische Grundlagen, Grundgleichungen der reibungsfreien und reibungsbehafteteten Strömung, Theorie des Auftriebs, induzierter Widerstand, Kompressibilitäts- und Reibungseffekte und ihre Einordnung über entsprechende Kennzahlen (Machzahl, Reynoldszahl), Grundzüge der Flugmechanik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. rer. nat. Dr. habil. Andreas Dillmann StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 2 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 5 - 6; Master: 1 - 2
Maximale Studierendenzahl: 30	
Bemerkungen: Schwerpunkt: AG, BK	

Georg-August-Universität Göttingen **Modul B.Phy.5502: Aktive Galaxien** *English title: Active galaxies*	3 C 2 SWS
Lernziele/Kompetenzen: Nach dem erfolgreichem Absolvieren des Moduls verfügen die Studierenden Kenntnisse in: • Klassifizierung von Aktiven Galaxien, • spektrale Eigenschaften, • Multifrequenzbeobachtungen, • Struktur und Komponenten der Kernregion, • supermassereiche Schwarze Loecher, • thermische und nichtthermische Strahlungsprozesse, • Energieerzeugung	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Aktive Galaxien (Vorlesung)	
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsanforderungen:** Beherrschen des Stoffs der Vorlesung und der zugehörigen Literatur.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundvorlesung zur Astronomie
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Wolfram Kollatschny
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Module B.Phy.5505: Data Analysis in Astrophysics**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students are able to model noise and signal.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Vorlesung (Lecture)	
Examination: Oral examination (approx. 30 minutes)	3 C

Examination requirements: Demonstrate an understanding of concepts developed in lecture: Introduction to methods of data analysis in astrophysics: Random signal and noise; correlation analysis; model fitting by least squares and maximum likelihood; Monte Carlo simulations; Fourier analysis; filtering; signal and image processing; Hilbert transform; mapping; applications to problems of astrophysical relevance.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1
Maximum number of students: 40	

Georg-August-Universität Göttingen **Modul B.Phy.5506: Einführung in die Strömungsmechanik** *English title: Introduction to fluid dynamics*	6 C 4 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden Begriffe der Strömungsmechanik auf entsprechende Fragestellungen aus den Bereichen der Geo- und Astrophysik bzw. der Biophysik und der Physik komplexer Systeme anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vorlesung (Vorlesung)	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	6 C
Prüfung: Mündlich (ca. 30 Minuten)	6 C
Prüfungsanforderungen: Theoretische und experimentelle Grundlagen der Strömungsmechanik tropfbarer Flüssigkeiten und Gase: Kontinuumshypothese; Statik, Kinematik und Dynamik von Fluiden; Kontinuitätsgleichung; Bewegungsgleichungen; Dimensionsanalyse; reibungsbehaftete Strömungen, schleichende Strömungen, Grenzschichten, Turbulenz; Potentialströmungen; Wirbelsätze; Impuls- /Impulsmomentengleichungen; Energiegleichung; Stromfadentheorie	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 3
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Phy.5508: Geophysikalische Strömungsmechanik** *English title: Geophysical fluid mechanics*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die Bewegungsformen der flüssigen Bestandteile der Erde (Atmosphäre, Ozeane, Kern) oder anderer Planeten kennen und die Thermodynamik, insbesondere der Atmosphäre, verstehen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung (Vorlesung)	
Prüfung: mündliche Prüfung (ca. 30 Min.) oder Klausur (30 Min.)	
Prüfungsanforderungen: Aufbau der Erdatmosphäre, adiabatischer Gradient und Temperaturschichtung, Corioliskraft und Besonderheiten rotierender Strömungen (geostrophisches Gleichgewicht, Inertial- und Rossbywellen, Ekmanschichten), Strahlungshaushalt, globale Zirkulation der Atmosphäre und Ozeane, Wettersysteme der mittleren Breiten, Schwerewellen, Konvektion, Instabilität und Turbulenz.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Tilgner
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 3
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen:
Schwerpunkt Astro-/Geophysik

Georg-August-Universität Göttingen **Modul B.Phy.551: Spezielle Themen der Astro- und Geophysik I** *English title: Special topics of Astro- and Geophysics I*	6 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren sollten die Studierenden aktuelle Forschungsthemen der Astro- und Geophysik verstehen und bewerten können. Sie sollten ihr Grundlagenwissen über Methoden und Modelle vertieft haben.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Veranstaltung aus dem Lehrangebot der Astro- und Geophysik	
Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit)	
Prüfungsanforderungen: Vertiefung der in den Einführungsveranstaltungen angeeigneten Kenntnisse in Astro- bzw. Geophysik; aktuelle Forschungsthemen der Astro-/Geophysik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Module B.Phy.5511: Magnetohydrodynamics**	3 C 2 WLH
Learning outcome, core skills: After successful comletion of this module, students should be able to apply the fundamental concepts and methods of magnetohydrodynamics to geo- and astrophysical problems.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Lecture (Lecture)	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examination (120 minutes)	3 C
Examination: Oral examination (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Andreas Tilgner
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen Module B.Phy.5513: Numerical fluid dynamics	6 C 4 WLH
Learning outcome, core skills: After completion of this module students should ... • know the basic methods for solving partial differential equations • be able to program and analyze numerical methods for the solution of partial differential equations.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Lecture with exercises	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Term Paper (max. 15 pages)	6 C
Examination: Oral examination (approx. 30 minutes)	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Andreas Tilgner
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5514: Physics of the Interior of the Sun and Stars**	3 C 2 WLH
Learning outcome, core skills: After successful completion of the modul students should be able ... • to understand the equations of stellar structure, • to understand current questions about the physics of solar/stellar interiors and magnetism, • to understand the physics of solar/stellar oscillations and their diagnostic potential.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Vorlesung (Lecture)	
Examination: Oral examination (approx. 30 minutes)	3 C
Examination requirements: Demonstrate an understanding of concepts developed in lecture: Introduction to stellar structure, evolution, and dynamics; rotation; convection; dynamos; observations of solar and stellar oscillations; introduction to stellar pulsations; normal modes; weak perturbation theory; numerical forward modeling	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Modul B.Phy.5516: Physik der Galaxien** *English title: Physics of Galaxies*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über Kenntnisse zu folgenden Schwerpunkten: • Klassifizierung von Galaxien, • Helligkeitsprofile, • spektroskopische Eigenschaften, • stellare Population und interstellares Medium, • Kinematik, • Massen(bestimmungsmethoden), • Galaxienentwicklung	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung (Vorlesung)	
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsanforderungen:** • morphologische Galaxienklassifikation, • Oberflaechenhelligkeit, • Aufbau und Struktur von Galaxien, • Rotation und Dynamik, • stellare Zusammensetzung und Gaskomponenten des Interstellaren Mediums, • Galaxienmassen, • Skalierungsrelationen, • Galaxienentwicklung	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Wolfram Kollatschny
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Module B.Phy.5517: Physics of the Sun, Heliosphere and Space Weather: Key Knowledge**	3 C 2 WLH
Learning outcome, core skills: After successful completion of the module the participants understand: • the elementary parameters of the Sun-Earth-System, • the origin and different forms of solar activity, • the physical processes of the heliosphere, • the exploration of space and the Sun with space missions, • the effects of the Sun on Earth and space weather.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Physics of the Sun, Heliosphere and Space Weather: Key Knowledge (Lecture) *Contents*: • Basic knowledge of the Sun-Earth-System, • Basic physics of the Sun, its outer atmosphere and its effects on interplanetary spac, • Exploration of the Sun and space with dedicated spacecraft and instruments, • Effects of the Sun on Earth, including cosmic effects, Finally, the research field of space weather, different forecast methods and new projects will be presented.	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examinationWritten examination (120 minutes)	3 C
Examination: Oral examinationoral examination (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Ansgar Reiners Contact Person: Dr. Bothmer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5518: Physics of the Sun, Heliosphere and Space Weather: Space Weather Applications**	3 C 2 WLH
Learning outcome, core skills: Learning outcome: Introduction into the physics processes of space weather based on applied study cases. Core skills: Knowledge about physical processes of space weather and its applications. Ability in self-organised solving of case studies.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Vorlesung (Lecture)	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examination (120 minutes)	3 C
Examination: Oral examination (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Ansgar Reiners Contact person: Dr. Bothmer
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.552: Spezielle Themen der Astro- und Geophysik II** *English title: Special topics of astro-/geophysics II*	6 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren sollten die Studierenden aktuelle Forschungsthemen der Astro- und Geophysik verstehen und bewerten können. Sie sollten ihr Grundlagenwissen über Methoden und Modelle vertieft haben.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Spezielle Themen der Astro- und Geophysik IIa	3 SWS
Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit) **Prüfungsanforderungen:** Vertiefung der in den Einführungsveranstaltungen angeeigneten Kenntnisse in Astro- bzw. Geophysik. Aktuelle Forschungsthemen der Astro-/Geophysik.	3 C
Lehrveranstaltung: Spezielle Themen der Astro- und Geophysik IIb	3 SWS
Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit) **Prüfungsanforderungen:** Vertiefung der in den Einführungsveranstaltungen angeeigneten Kenntnisse in Astro- bzw. Geophysik. Aktuelle Forschungsthemen der Astro-/Geophysik.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Modul B.Phy.5521: Seminar zu einem Thema der Geophysik** *English title: Seminar on Geophysics*	4 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten Studierende sich selbstständig in eine Fragestellung aus der Geophysik und Ihrem fachlichen Umfeld einarbeiten und einen Vortrag mit schriftlicher Zusammenfassung erarbeiten können**.**	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Seminar (Seminar)	
Prüfung: Vortrag (ca. 60 Min.) mit schriftlicher Ausarbeitung (max. 20 S) **Prüfungsvorleistungen:** Aktive Teilnahme	4 C
Prüfungsanforderungen: Selbständige Einarbeitung in ein Thema der Geophysik, Vorbereitung eines für Bachelor-Studenten verständlichen Vortrages mit schriftlicher Zusammenfassung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Tilgner
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 3
Maximale Studierendenzahl: 20	

Bemerkungen: Schwerpunkt Astro-/Geophysik

Georg-August-Universität Göttingen Module B.Phy.5523: General Relativity	6 C 6 WLH
Learning outcome, core skills: The students master the foundations of General Relativity mathematically and physically. They are able to perform corresponding computations in simple models.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: General Relativity (Lecture)	4 WLH
Examination: Written examination (120 minutes) **Examination requirements:** Basic structures of Differential geometry, simple examles of computations, Einstein's equation, underlying principles, Schwarzschild space-time, classical tests of General Relativity, foundations of cosmology.	6 C
Course: Excercises	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of Mechanics, Electrodynamics and special Relativity, Analysis of several real variables
Language: German, English	**Person responsible for module:** apl. Prof. Folkert Müller-Hoissen
Course frequency: Two-year as required / Winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 60	

Georg-August-Universität Göttingen Module B.Phy.5531: Origin of solar systems	3 C 2 WLH
Learning outcome, core skills: After finishing the module the students should be able to apply the fundamental knowledge about the structure and the formation of planetary systems to geophysical and astrophysical problems.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Lecture (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Theory and observation of early phases of stars and planetary systems, including extrasolar planets and our own solar system. In particular: Early phases of formation of stars and protoplanetary disks, models of the condensation of molecules and minerals during formation of planetary systems, chemistry and radiation in low-density astrophysical environments, formation of planets and their migration, small solar system bodies as source of information on the early solar system.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Astropyhsics
Language: German, English	**Person responsible for module:** Prof. Dr. Stefan Dreizler Ansprechpartner: Dr. Jockers, Dr. Krüger
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** from 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5538: Stellar Atmospheres**	6 C 4 WLH
Learning outcome, core skills: After successful completion of the modul students should know how to applicate physical concepts (such as atomic and molecular physics, thermodynamics, and statistical physics) in an astrophysical context, and know their implementation in numerical simulations.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Physics of stellar atmospheres (Vorlesung) *Course frequency:* each winter semester	2 WLH
Course: Stellar atmosphere modelling (Computerpraktikum) *Course frequency:* each winter semester	2 WLH
Examination: Oral Exam (ca. 30 Min.)	6 C
Examination requirements: Oral account of the context and concepts learned during the two courses on the topics of interaction of radiation and matter; radiative transfer; structure of stellar atmospheres; and theoretical foundations of spectral analysis; answering of specific questions on all the aspects in this field.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Dreizler
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Additional notes and regulations: Schwerpunkt: Astro-/Geophysik

Georg-August-Universität Göttingen **Module B.Phy.5539: Physics of Stellar Atmospheres**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should understand the interaction of radiation and matter, radiative transfer, structure of stellar atmospheres; thorough understand the theoretical foundations of spectral analysis and know how to applicate physical concepts (such as atomic and molecular physics, thermodynamics, and statistical physics) in an astrophysical context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Physics of stellar atmospheres (Vorlesung)	
Examination: Oral Exam (ca. 30 Min.)	3 C

Examination requirements: Oral account of the context and concepts of radiative transfer and structure of stellar atmospheres.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Dreizler
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Additional notes and regulations: Schwerpunkt: Astro-/Geophysik

Georg-August-Universität Göttingen **Module B.Phy.5540: Introduction to Cosmology**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should understand the evolution of the universe on very large scales, knowledge of current questions in physical cosmology.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture Introduction to Cosmology	
Examination: written (120 min.) or oral (ca. 30 min.) exam **Examination requirements:** Key concepts and calculations from homogeneous cosmology: Newtonian cosmology; relativistic homogeneous isotropic cosmology; horizons and distances; the hot universe; Newtonian inhomogeneous cosmology; inflation. This course will be based on video lectures and short quizzes that will be discussed in class.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Jens Carsten Niemeyer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 3
Maximum number of students: 20	

Additional notes and regulations: Schwerpunkt: Astro-/Geophysik; Kern-/Teilchenphysik

Georg-August-Universität Göttingen Module B.Phy.5544: Introduction to Turbulence	3 C 2 WLH
Learning outcome, core skills: **Learning objectives:** In this course, the students will be introduced to the phenomenon of turbulence as a complex system that can be treated with methods from non-equilibrium statistical mechanics. The necessary statistical tools will be introduced and applied to obtain classical and recent results from turbulence theory. Furthermore, current numerical and experimental techniques will be discussed. **Competencies:** The students shall gain a fundamental understanding of turbulent flows as a problem of non-equilibrium statistical mechanics. Part of the course will be held in tutorial style in which textbook problems will be discussed in detail. The course shall also strengthen the students' ability to perform interdisciplinary work by stressing the interdisciplinary aspects of the field with connections to pure and applied math as well as engineering sciences.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Introduction to Turbulence (Lecture)	
Examination: Written exam (90 min.) or oral exam (approx. 30 min.) **Examination requirements:** Basic knowledge and understanding of the material covered in the course such as: continuum description of fluids (Navier-Stokes equations), non-dimensionalization & dimensional analysis, Kolmogorov phenomenology, intermittency, exact statistical approaches & the closure problem, soluble models of turbulence.	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic Knowledge in continuum mechanics or electrodynamics
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen Module B.Phy.5546: Excursion: Astronomical Observing Course	6 C 4 WLH
Learning outcome, core skills: Advanced knowledge about observation planning and execution as well as data analysis and presentation of results.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Astronomical Observing Course (Excursion)	4 WLH
Examination: Poster presentation on a self-chosen research topic (approx. 15 min.) **Examination prerequisites:** Regular Participation in the excursion and the weekly preparation tutorials and data analysis sessions. **Examination requirements:** Advanced knowledge about observation planning and execution as well as data analysis and presentation of results.	

Admission requirements: none	**Recommended previous knowledge:** B.Phy.1551: Introduction to Astrophysics
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Dreizler Dr. Tim-Oliver Husser, Dr. Fabian Göttgens
Course frequency: each winter semester, depending on availability of observing time	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 10	

Georg-August-Universität Göttingen **Modul B.Phy.556: Seminar zu speziellen Themen der Astro-/ Geophysik** *English title: Seminar Astro-/Geophysics*	4 C 2 SWS

Lernziele/Kompetenzen: **Lernziele:** Umgang mit Präsentationsmedien und Präsentation komplexer Sachverhalte vor Experten und fachfremden Zuhörern, Kommunikations- und Diskussionsfähigkeit, Kritikfähigkeit und Ausdrucksfähigkeit. **Kompetenzen:** Die Studierenden können selbständig den Inhalt wissenschaftlicher Publikationen (in der Regel englischsprachig) aus dem Bereich der Astro-/Geophysik erarbeiten und vor einem breiten Publikum präsentieren.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: B.Phy.556: Seminar zu speziellen Themen der Astro-/ Geophysik (Seminar)	2 SWS
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** aktive Teilnahme **Prüfungsanforderungen:** Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation aus dem Bereich der Astro-/Geophysik. 4 Wochen Vorbereitungszeit	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan/in der Fakultät für Physik
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Phy.5601: Theoretical and Computational Neuroscience I** *English title: Theoretical and Computational Neuroscience I*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • ein vertieftes Verständnis folgender Themen entwickelt haben: TCN I: biophysikalische Grundlagen neuronaler Anregbarkeit, mathematische Grundlagen neuronaler Anregbarkeit, Input-Output Beziehungen und Bifurkationen, Klassifizierung, Existenz, Stabilitaet und Koexistenz sychroner und asynchroner Zustaende in spikenden neuronalen Netzwerken; • Methoden und Methodenentwicklung für die Analyse hochdimensionaler Modelle ratenkodierter Einheiten in Feldmodellen verstehen; • die Handhabung von Bifurkationsszenarien und zugehörigen Instabilitäten verstanden haben.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Collective Dynamics Biological Neural Networks I (Vorlesung)	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	3 C
Prüfung: Mündlich Mündliche Prüfung (ca. 30 Minuten)	3 C
Prüfung: Vortrag (2 Wochen Vorbereitungszeit) (30 Minuten)	3 C
Prüfungsanforderungen: Grundlagen der Membranbiophysi;, Bifurkationen anregbarer Systeme; Verständnis der Grundlagen der Modellierungsansätze der Neurophysik; kollektive Zustände spikender neuronaler Netzwerke; insbesondere Synchonizität; Balanced State; Phase-Locking und diesen Zuständen unterliegenden lokalen und Netzwerkeigenschaften: Netzwerktopologie; Delays; inhibitorische und exzitatorische Kopplung; sparse random networks	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Fred Wolf
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Modul B.Phy.5602: Theoretical and Computational Neuroscience II** *English title: Theoretical and Computational Neuroscience II*	3 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten Studierende... • das vertiefte Verständnis folgender Themen entwickelt haben: TCN II: Grundlagen neuronaler Anregbarkeit, Input-Output Beziehungen bei Einzelneuronen, eindimensionale Feldmodelle (Feature Selectivity, Contrastinvariance), zweidimensionale Feldmodell (Zusammenwirken von kurz- und langreichweitigen Verbindungen sowie lokaler Nichtlinearitaeten), Amplitudengleichungen und ihre Loesungen; • Methoden und Methodenentwicklung für die Analyse spikender neuronaler Netzwerke mit und ohne Delays, Handhabung von Bifurkationsszenarien und zugehörigen Instabilitäten verstehen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Collective Dynamics Biological Neural Networks II (Vorlesung)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	3 C
Prüfung: Mündlich (ca. 30 Minuten)	3 C
Prüfung: Seminarvortrag (2 Wochen Vorbereitungszeit) (30 Minuten)	3 C

Prüfungsanforderungen: Ratenmodelle von Einzelneuronen; Feldansatz in der theoretischen Neurophysik; Grundlagen der Bifurkationen anregbarer System; Verständnis der Grundlagen der Modellierungsansätze der Neurophysik; Zusammenhang diskrete/kontinuierliche Modelle; kollektive Zustände ein- und zweidimensionaler Feldmodelle, insbesondere ring model of feature selectivity; orientation preference maps.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Fred Wolf
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Modul B.Phy.5603: Einführung in die Laserphysik** *English title: Introduction to laserphysics*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über folgende Grundkenntnisse: • Die dem Laser zugrundeliegenden Prinzipien. • Die Beschreibung des Laserprozesses durch Ratengleichungen sowie stationäre und zeitabhängige Lösungen derselben. • Stabilität von Laserresonatoren sowie Eigenschaften der aus Ihnen emittierten Strahlung. • Aufbau und Eigenschaften unterschiedlicher Lasertypen. • Ausgewählte Laserprobleme (Linienbreite, Hole Burning, Kurze Pulse, …)	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung *Inhalte*: Das Prinzip des Lasers wird aufbauend auf einfachen Grundbegriffen entwickelt, dabei aber keineswegs auf quantitative Aussagen verzichtet. Im Mittelpunkt stehen die Analyse des stationären und zeitabhängigen Verhaltens von Lasern mit Hilfe des Ratengleichungsmodelles sowie die Diskussion optischer Resonatoren. Weiterhin werden die physikalischen Grundideen am Beispiel der wichtigsten Lasertypen herausgearbeitet. Eine einführende Behandlung einiger ausgewählter Probleme (Linienbreite, Hole Burning, Kurze Pulse, …) rundet die Vorlesung ab.	
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsanforderungen:** Laserprinzip; Ratengleichungen; Funktionsweise von Lasern (Festkörper, Farbstoff, Gas, Halbleiter und Freier-Elektronen); Wellengleichung; strahlen- und wellenoptische Behandlung von Resonatoren. Entwicklung des Laserprinzips aus einfachen Grundbegriffen: Licht und Materie, Laserprinzip, Ratengleichungen, Lasertypen, optische Resonatoren, ausgewählte Themen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** apl. Prof. Dr. Alexander Egner
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 4
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module B.Phy.5604: Foundations of Nonequilibrium Statistical Physics**	3 C 2 WLH

Learning outcome, core skills: **Lernziele**: Invariant densities of phase-space flows with local and global conservation of phase-space volume; reduction of a microscopic dynamics to a stochastic description, to kinetic theory and to hydrodynamic transport equations; fluctuation theorems; Green-Kubo relations; local equilibrium; entropy balance and entropy production; the second law; statistical physics of equilibrium processes as a limit of a non-equilibrium processes; applications in nanotechnology and biology: small systems far from thermodynamic equilibrium. **Kompetenzen**: After successful completion of the modul the students should know modeling approaches for a statistical-physics description of small systems far from thermodynamic equilibrium: in homework problems, that will be presented in a subsequent symposium, this will be highlighted by explicitly working out examples in nanotechnology and biology.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: lecture	
Examination: Presentation (approx. 30 min) and handout (max. 4 pages)	3 C

Examination requirements: Modeling of an experimental system by a Master equation, kinetic theory or Non-Equilibrium Molecular Dyanamics with discussion of the appropriate fluctuation relations and/or the relation of models on different levels of coarse graining.	

Admission requirements: none	**Recommended previous knowledge:** Statistische Physik
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 20	

Georg-August-Universität Göttingen Module B.Phy.5605: Computational Neuroscience: Basics	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Goals: Introduction to the different fields of Computational Neuroscience: • Models of single neurons, • Small networks, • Implementation of all simple as well as more complex numerical computations with few neurons. • Aspects of sensory signal processing (neurons as ‚filters'), • Development of topographic maps of sensory modalities (e.g. visual, auditory) in the brain, • First models of brain development, • Basics of adaptivity and learning, • Basic models of cognitive processing. **Kompetenzen/Competences:** On completion the students will have gained… • … overview over the different sub-fields of Computational Neuroscience; • … first insights and comprehension of the complexity of brain function ranging across all sub-fields; • … knowledge of the interrelations between mathematical/modelling methods and the to-be-modelled substrate (synapse, neuron, network, etc.); • … access to the different possible model level in Computational Neuroscience.	Attendance time: 28 h Self-study time: 62 h

Course: Computational Neuroscience: Basics (Lecture)	
Examination: Written examination (45 minutes) **Examination requirements:** Actual examination requirements: Having gained overview across the different sub-fields of Computational Neuroscience; Having acquired first insights into the complexity of across the whole bandwidth of brain function; Having learned the interrelations between mathematical/modelling methods and the to-be-modelled substrate (synapse, neuron, network, etc.) Being able to realize different level of modelling in Computational Neuroscience.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 2 - 6; Master: 1 - 4

Georg-August-Universität Göttingen **Module B.Phy.5607: Seminar: Mechanics and dynamics of the cytoskeleton**	4 C 2 WLH

Learning outcome, core skills: After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar: Mechanics and dynamics of the cytoskeleton	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Polymer physics and polymer networks; membranes; physics on small scales; cell mechanics; molecular motors; cell motility; dynamics in the cell.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5608: Micro- and Nanofluidics**	3 C 2 WLH
Learning outcome, core skills: Students will learn the fundamentals of fluid dynamics, hydrodynamics on the micro- and nanoscale, wetting and capillarity and “life” at low Reynolds numbers. Students will also learn the how these topics are studied/applied in experiments, learn about device fabrication using soft lithography and the use of fluidics in biology and biophysics including “lab-on-a-chip” applications. After successfully completing this course, students will be familiar with basic hydrodynamics and their applications at scales applicable to biology, biophysics, material sciences and biotechnology.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Micro- and Nanofluidics (Lecture)	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examination (60 minutes)	3 C
Examination: Oral examination (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: every 4th semester; summerterm, in even years	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Modul B.Phy.561: Spezielle Themen der Biophysik und Physik komplexer Systeme I** *English title: Specific topics of Biophysics/Physics of complex systems I*	6 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren sollten die Studierenden aktuelle Forschungsthemen der Biophysik/Physik komplexer Systeme verstehen und bewerten können. Sie sollten ihr Grundlagenwissen über Methoden und Modelle vertieft haben.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Veranstaltung aus dem Lehrangebot der Biophysik und Physik komplexer Systeme	
Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit)	
Prüfungsanforderungen: Vertiefung in der den Einführungsveranstaltungen angeeigneten Kenntnisse in Biophysik/Physik komplexer Systeme. Aktuelle Forschungsthemen der Biophysik/Physik komplexer Systeme.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Module B.Phy.5611: Optical spectroscopy and microscopy**	3 C 2 WLH
Learning outcome, core skills: **Learning outcome**: Physical basics of fluorescence and fluorescence spectroscopy, fluorescence anisotropy, fluorescence lifetime, fluorescence correlation spectroscopy, basics of optical microscopy, resolution limit of optical microscopy, wide field and confocal microscopy, super-resolution microscopy. **Core skills:**The students shall learn the basics and applications of advanced fluorescence spectroscopy and microscopy, including single-molecule spectroscopy and all variants of super-resolution fluorescence microscopy.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Lecture	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Fundamental understanding oft he physics of fluorescence and the applications of fluorescence in spectroscopy and microscopy.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5613: Soft Matter Physics**	3 C 2 WLH
Learning outcome, core skills: **Learning objectives** After successfully finishing this course, students will be familiar with fundamental concepts of soft condensed matter physics and their applications. Topics include: intermolecular interactions; phase transitions; interface physics; amphiphilic molecules; colloids; polymers; polymer networks; gels; fluid dynamics; self-organization. **Learning outcomes:** Students will be able to apply these fundamental concepts independently to specific questions. They will be able to use the knowledge learned to critically evaluate the current literature.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Soft Matter Physics (Lecture)	2 WLH
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examinationwritten exam (120 minutes)	3 C
Examination: Oral examinationoral exam (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to…Biophysics or/and Physics of complex systems or/and Solid State Physics or/and Materials Physics
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: every 4th semester; summerterm, in odd years	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen Module B.Phy.5614: Proseminar Computational Neuroscience	4 C 2 WLH
Learning outcome, core skills: After successful completion of the module, students have deepened their knowledge in computational neuroscience / neuroinformatics by independent preparation of a topic. They should... - know and be able to apply methods of presentation of topics from computer science; - be able to deal with (English-language) literature; - be able to present a topic of computer science; - be able to lead a scientific discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Proseminar	
Examination: Talk (approx. 45 Min.) with written report (max. 7 S.) **Examination requirements:** Proof of the acquired knowledge and skills to deal with scientific literature from the field of computational neuroscience / neuroinformatics under guidance by presentation and preparation.	4 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5605
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 3
Maximum number of students: 14	

Georg-August-Universität Göttingen Module B.Phy.5617: Seminar: Physics of soft condensed matter	4 C 2 WLH
Learning outcome, core skills: After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar: Physics of soft condensed matter	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Intermolecular interactions; phase transitions; interface physics; amphiphilic molecules; colloids; polymers; polymer networks; gels; fluid dynamics; self-organization.	4 C

Admission requirements: none	**Recommended previous knowledge:** • Introduction to Biophysics and/or • Introduction to Complex Systems and/or • Introduction to Solid State Physics and/or • Introduction to Materials Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5618: Seminar to Biophysics of the cell - physics on small scales**	4 C 2 WLH
Learning outcome, core skills: After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Physical principles in cells; adhesion; motility; cellular communication; signal transduction; biopolymers and networks; nerve cinduction; extracellular matrix; experimental methods; current research.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophyiscs and/or Introduction to Physics of Complex Systems
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen Module B.Phy.5619: Seminar on Micro- and Nanofluidics	4 C 2 WLH
Learning outcome, core skills: After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar on Micro- and Nanofluidics (Seminar)	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Fluid dynamics, hydrodynamics on the micro- and nanoscale and its applications in biology, biophysics, material sciences and biotechnology; wetting and capillarity; “life” at low Reynolds numbers; soft lithography; fluidics in biology and biophysics, “lab-on-a-chip” applications; Navier-Stokes-Equation.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Modul B.Phy.562: Spezielle Themen der Biophysik und Physik komplexer Systeme II** *English title: Specific Topics of Biophysics/Physics of Complex Systems II*	6 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren sollten die Studierenden aktuelle Forschungsthemen der Biophysik/Physik komplexer Systeme verstehen und bewerten können. Sie sollten ihr Grundlagenwissen über Methoden und Modelle vertieft haben.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Veranstaltung aus dem Lehrangebot der Biophysik und Physik komplexer Systeme IIa	3 SWS
Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit)	3 C
Lehrveranstaltung: Veranstaltung aus dem Lehrangebot der Biophysik und Physik komplexer Systeme IIb	3 SWS
Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit)	3 C
Prüfungsanforderungen: Vertiefung der in den Einführungsveranstaltungen angeeigneten Kenntnisse in Biophysik/Physik komplexer Systeme; aktuelle Forschungsthemen der Biophysik/Physik komplexer Systeme.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 2 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Module B.Phy.5620: Physics of Sports**	4 C 2 WLH
Learning outcome, core skills: After completing this module a student should be able to: • Research a topic in the scientific literature and analyse it critically. • Show fundamental skills in model building and, for example, in the discussion of nonlinear differential equations or other complex physical models.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar	
Examination: Presentation with discussion (approx. 45 minutes) and supplementary report (max. 4 pages) **Examination prerequisites:** Active participation	
Examination requirements: The student should: Present a summary of the key physics underlying a particular sport; Explain the topic from intuition to a deep description of the relevant physical facts or foundation; Set up an appropriate model and discuss the solution. Where appropriate, the student must take into account a critical discussion of the relevant literature.	

Admission requirements: none	**Recommended previous knowledge:** Basic analytical mechanics and fluid dynamics.
Language: English, German	**Person responsible for module:** Prof. Dr. Stephan Herminghaus Contact persons: Dr. O. Bäumchen, Dr. M. Mazza
Course frequency: unegular, two year as required	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module B.Phy.5623: Theoretical Biophysics**	6 C 4 WLH
Learning outcome, core skills: **Learning outcome:** Basics of probability theory, Bayes Theorem, Brownian motion, stochastic differential equations, Langevin equation, path integrals, Fokker-Planck equation, Ornstein-Uhlenbeck processes, thermophoresis, chemotaxis, Fluctuation Dissipation Theorems, Stochastic Resonance, Thermal Ratchet, motor proteins, hydrodynamics at the nanoscale, population dynamics, Jarzynski relations, non-equilibrium thermodynamics, neural networks. **Core skills:** The core coal is to teach students fundamental theoretical concepts about stochastic systems in the widest sense, an the application of these concepts the biophysics of biomolecules, cells and populations.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Vorlesung mit Selbststudium Literatur	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Derivation of fundamental relations describing stochastic systems, derivation, handling and explanation of differential equations, derivation of analytical and approximative solutions for the various considered problems.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Jörg Enderlein
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen Module B.Phy.5624: Introduction to Theoretical Neuroscience	4 C 2 WLH
Learning outcome, core skills: After successfully completing this course, students should understand and be able to employ the fundamental concepts, model representations and mathematical methods of the theoretical physics of neuronal systems.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar	
Examination: Lecture (approx. 60 minutes) **Examination prerequisites:** Active Participation **Examination requirements:** Elementary knowledge of the construction, biophysics and function of nerve cells; probabilistic analysis of sensory encoding; simple models of the dynamics and information processing in networks of biological neurons; modelling of the biophysical foundations of learning processes.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Fred Wolf
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen Module B.Phy.5625: X-ray physics	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Knowledge in: • Radiation-matter interaction • Dosimetry, radiobiology and radiation protection • Scattering experiments: photons, neutrons and electrons • Fundamental concepts in diffraction and Fourier theory • Structure analysis in crystalline and non-crystalline condensed matter • Generation of x-rays and synchrotron radiation • X-rays optics and detection • X-ray spectroscopy, microscopy and imaging After taking the course, students • will integrate fundamental concepts of matter-radiation interaction . • are able to apply quantitative scattering techniques with short wavelength radiation for structure analysis of condensed matter, including problems in solid state, materials, soft matter, and biomolecular physics • are able to plan and carry out x-ray laboratory experiments • are prepared to participate in beamtimes at synchrotron, neutron or free-electron radiation sources • can solve analytical problems in x-ray optics, diffraction and imaging	Attendance time: 56 h Self-study time: 124 h

Course: X-ray Physics	
Examination: Written examination (120 minutes) or oral examination (ca. 30 min.) or presentation (ca. 30 min.) **Examination prerequisites:** none **Examination requirements:** • solve problems of the topics mentioned above on a quantitative level, including calculations of structure factor, correlation functions, • applications of Fourier theory to structure analysis and basic solutions to the phase problem, • solve problems of wave optical propagation and diffraction • knowledge about interaction mechanisms and order -of-magnitude estimations, • knowledge about theoretical concepts and experimental implementations of different techniques, • knowledge of laboratory skills (x-ray sources, detection, dosimetry)	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Tim Salditt

Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 15	

Georg-August-Universität Göttingen Module B.Phy.5629: Nonlinear dynamics and time series analysis	6 C 4 WLH
Learning outcome, core skills: Sound knowledge and practical experience with methods and concepts from Nonlinear Dynamics and Time Series Analysis, mainly obtained by devising, implementing, and running algorithms and simulation programs.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Blockpraktikum	
Examination: Presentation with discussion (approx. 45 minutes) and written elaboration (max. 10 pages) **Examination requirements:** • Presentation of a specific topic • Report about own (simulation) results obtained for the specific topic	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic programming skills (for the exercises)
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Ulrich Parlitz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 12	

Additional notes and regulations:
(Duration: 2 weeks with 8h per day)

Georg-August-Universität Göttingen Module B.Phy.5631: Self-organization in physics and biology	4 C 2 WLH
Learning outcome, core skills: **Learning outcome**: basics of self-organization, non-equilibrium dynamics, cell migration, cilia dynamics and cardiac dynamics. **Core skills:** Upon successful seminar participation, the students should be capable of - accomplish literature research autonomously and therefore understand and analyse scientifc articles in the corresponding scientific context - create a presentation including physical and biological basics relevant to the scientific article and give the oral presentation	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar	
Examination: Presentation (approx. 45 Min.) **Examination prerequisites:** Active Participation **Examination requirements:** Elaborated presentation, which includes an introduction to the necessary basics	4 C

Admission requirements: none	**Recommended previous knowledge:** -Introduction to biophysics -Introduction to physics of complex systems
Language: English	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 12	

Georg-August-Universität Göttingen **Module B.Phy.5632: Current topics in turbulence research**	4 C 2 WLH

Learning outcome, core skills: **Learning outcome:** Based on a selected topic the students shall develop a basic understanding of turbulent flows. **Core skills**: The goal of this course is to enable the students to present their research in the context of the international state of the art of the field.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar	WLH
Examination: Presentation (approx. 45 Min.) **Examination prerequisites:** Active Participation **Examination requirements:** Basic understanding of turbulence; instabilities, scaling, models of turbulence, turbulence in rotating and stratified systems, turbulent heat transport, particles in turbulence	4 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of advanced continuum mechanics or electrodynamics.
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 15	

Georg-August-Universität Göttingen **Module B.Phy.5639: Optical measurement techniques**	3 C 2 WLH
Learning outcome, core skills: After successful completion of the module, students should ... • be able to apply light models • have understood basic optical principles of measurement • have gained an overview of optical measurement method for measuring different physical quantities at different scales	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Optical Measurement Techniques (Lecture)	
Examination: Presentation with discussion (approx. 30 min.) or oral examination (approx. 30 Min.) **Examination requirements:** Understanding optical measurement principles and methods	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik / Ansprechpartner: Dr. Nobach
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen Module B.Phy.5645: Nanooptics and Plasmonics	3 C 2 WLH
Learning outcome, core skills: After the course, the students should have a profound knowledge about the rapidly evolving field nanooptics and plasmonics, both experimentally as well as theoretically.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Nanooptics and Plasmonics (Lecture)	
Examination: Written examination (90 min.) or oral examination (approx. 30 Min.) **Examination requirements:** Electrodynamics of single particle/molecule emission, electrodynamic interaction of nano-emitters and molecules with light, interaction of light with nanoscale dielectric and plasmonic structures, and with optical metamaterials. Theory of light-matter interaction at the nanometer length scale. Fundamentals of optical microscopy and spectroscopy, applied to optical quantum emitters.	3 C

Admission requirements: none	**Recommended previous knowledge:** Experimental Physics I-IV
Language: German, English	**Person responsible for module:** Prof. Dr. Jörg Enderlein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5646: Climate Physics**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: This course will introduce the physical principles of the Earth's climate, and the dynamics of our atmosphere and oceans. We will show how the basic features of a climate system can be understood through a detailed energy balance. A momentum balance, in the form of the Navier-Stokes equations, and mass balance, give rise to many of the additional behaviours of a real climate system. The main features of atmospheric and ocean circulation, mixing, and transport will be discussed in this context, including such topics as the thermohaline circulation; turbulent mixing; atmospheric waves; and Coriolis effects. We will then return to the global energy budget, and discuss physically grounded models of climate prediction and climate sensitivity (e.g. Milankovitch cycles), as well as their implications. In the latter part of the course, additional context on related questions of current research will be covered in special topics presented by members of the Göttingen Research Campus. **Core skills:** After successful completion of the modul the students should ... • know how to approach the study of climate in planetary systems from a rigorous physical perspective; • know which factors influence the climate, and how to analyse climate patterns and stability; • be able to develop a familiarity with the principles of climate science, and apply these to a broad range of situations, from the large-scale convection patterns in atmospheres and oceans, to the impact of clouds and precipitation, and box models for the energy and entropy budget.	Attendance time: 56 h Self-study time: 124 h

Course: Lecture with exercises	
Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Profound geophysical basis for the work on issues of climate physics.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basics of Hydrodynamics
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Jürgen Vollmer
Course frequency: two year as required, winter term or summer term	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module B.Phy.5647: Physics of Coffee, Tea and other drinks**	4 C 2 WLH
Learning outcome, core skills: After completing this module a student should be able to: • Research a topic in the scientific literature and analyse it critically. • Show fundamental skills in model building and, for example, in the discussion of nonlinear differential equations or other complex physical models. • Understand the phase behaviour of two (or more) component mixtures, the kinetics of phase separation, the physics of multi-phase fluids and soft materials such as foams and gels.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Physics of Coffee, Tea and other drinks (Seminar)	
Examination: Presentation with discussion (approx. 45 minutes) and written elaboration (max. 4 pages) **Examination prerequisites:** Active Participation **Examination requirements:** Presentation of a complex physical summary of the key physics underlying a mixed drink, or other beverage (e.g. drainage of foam in espresso, slow waves and convective stripes in latte macchiato, bubble formation and growth in champagne). Where appropriate, the student must take into account a critical discussion of the relevant literature.	4 C

Admission requirements: none	**Recommended previous knowledge:** Basic analytical mechanics and fluid dynamics
Language: German, English	**Person responsible for module:** Prof. Dr. Stephan Herminghaus Contact Person: Dr. M. Mazza
Course frequency: unregular, two year as required	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen Module B.Phy.5648: Theoretical and Computational Biophysics	4 C 2 WLH
Learning outcome, core skills: This combined lecture and hands-on computer tutorial focuses on the basics of computational biophysics and deals with questions like "How can the particle dynamics of thousands of atoms be described precisely?" or "How does a sequence alignment algorithm function?" The aim of the lecture with exercises is to develop a physical understanding of those "nano maschines" by using modern concepts of non-equilibrium thermodynamics and computer simulations of the dynamics on an atomistic scale. Moreover, the lecture shows (by means of examples) how computers can be used in modern biophysics, e.g. to simulate the dynamics of biomolecular systems or to calculate or refine a protein structure. No cell could live without the highly specialized macromolecules. Proteins enable virtually all tasks in our bodies, e.g. photosynthesis, motion, signal transmission and information processing, transport, sensor system, and detection. The perfection of proteins had already been highly developed two billion years ago. During the exercises, the knowledge presented in the lecture will be applied to practical examples to further deepen and strengthen the understanding. By completing homework sets, which will be distributed after each lecture, additional aspects of the addressed topics during the lecture shall be worked out. The homework sets will be collected during the corresponding exercises.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Theoretical and Computational Biophysics (Lecture, Exercise)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Protein structure and function, physics of protein dynamics, relevant intermolecular interactions, principles of molecular dynamics simulations, numeric integration, influence of approximations, efficient algorithms, parallel programing, methods of electrostatics, protonation balances, influence of solvents, protein structure determination (NMR, X-ray), principal component analysis, normal mode analysis, functional mechanisms in proteins, bioinformatics: sequence comparison, protein structure prediction, homology modeling, and hands-on computer simulation.	4 C

Admission requirements: none	**Recommended previous knowledge:** • Introduction to Biophysics • Introduction to Physics of Complex Systems
Language: English, German	**Person responsible for module:** Hon.-Prof. Dr. Karl Helmut Grubmüller
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students:	

30	

Georg-August-Universität Göttingen Module B.Phy.5649: Biomolecular Physics and Simulations	4 C 2 WLH
Learning outcome, core skills: **Learning objectives:** This combined lecture and hands-on computer tutorial offers the possibility to deepen the knowledge about theory and computer simulations of biomolecular systems, particularly proteins, and can be understood as continuation of the lecture with exercises "Theoretical and Computational Biophysics" (usually taking place in the previous winter semester). During the exercises, the knowledge presented in the lecture will be applied to practical examples to further deepen and strengthen the understanding. By completing homework sets, which will be distributed after each lecture, additional aspects of the addressed topics during the lecture shall be worked out. The homework sets will be collected during the corresponding exercises. **Competencies:** Whereas the winter term lecture with exercises "Theoretical and Computational Biophysics" emphasized the principles of running and analysing simple atomistic force field-based simulations, this advanced course will broaden our view and introduce basic principles, concepts and methods in computational biophysics, particularly required to understand biomolecular function, namely thermodynamic quantities such as free energies and affinities. Further, inclusion of quantum mechanical simulation techniques will allow to also simulate chemical reactions, e.g., in enzymes.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Lecture with Exercises Biomolecular Physics and Simulations	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Basic knowledge and understanding of the material covered in the course such as: Free energy calculations, Rate Theory, Non-equilibrium thermodynamics, Quantum mechanical methods (Hartree-Fock and Density Functional Theory), enzymatic catalysis; “handson” computational calculations and simulations	4 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5648 Theoretical and Computational Biophysics
Language: English, German	**Person responsible for module:** Hon.-Prof. Dr. Karl Helmut Grubmüller
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen Module B.Phy.5651: Advanced Computational Neuroscience	3 C 2 WLH
Learning outcome, core skills: Participants in the course can explain and relate biological foundations and mathematical modelling of selected (neuronal) algorithms for learning and pattern formation. Based on the the algorithms' properties, they can discuss and derive possible technical applications (robots).	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Advanced Computational Neuroscience I (Lecture)	
Examination: Written examination (90 Min.) or oral examination (approx. 20 Min.) **Examination requirements:** Algorithms for learning: • Unsupervised Learning (Hebb, Differential Hebb), • Reinforcement Learning, • Supervised Learning Algorithms for pattern formation. Biological motivation and technical Application (robots).	3 C

Admission requirements: none	**Recommended previous knowledge:** Basics Computational Neuroscience
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

Additional notes and regulations:
Hinweis: Die B.Phy.5652 kann als vorlesungsbegleitendes Praktikum besucht werden.

Georg-August-Universität Göttingen Module B.Phy.5652: Advanced Computational Neuroscience II	3 C 2 WLH
Learning outcome, core skills: Participants in the course can implement, test, and evaluate the properties of selected (neuronal) algorithms for learning and pattern formation.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced Computational Neuroscience II	
Examination: 4 Protocols (max. 3 Pages) and Presentations (ca. 10 Min.), not graded **Examination requirements:** Algorithms for learning: • Unsupervised Learning (Hebb, Differential Hebb), • Reinforcement Learning, • Supervised Learning Algorithms for pattern formation. Biological motivation and technical Application (robots). *For each of the 4 programming assignments 1 protocol (ca. 3 pages) and 1 oral presentations (demonstration and discussion of the program, ca. 10 min).*	3 C

Admission requirements: B.Phy.5651 (can be taken in parallel to B.Phy.5652)	**Recommended previous knowledge:** Programming in C++, basic numerical algorithms, Grundlagen Computational Neuroscience B.Phy.5504: Computational Physics (Scientific Computing)
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 24	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.Phy.5654: Vorlesung: Principles and Applications of Synchrotron and Free Electron Laser Radiation
English title: Lecture: Principles and Applications of Synchrotron and Free Electron Laser Radiation</td><td>3 C
4 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Learning objectives:
The aim of the course is the close connection of teaching in the field of X-ray physics with the work on major research centres, in particular research in photon science at DESY.
During the lecture the students receive an introduction to research on synchrotron radiation and free electron laser radiation: generation of the radiation and characteristics of the sources, basics of accelerator physics, experimental structures (beam tubes), fundamentals of X-ray diffraction and X-ray spectroscopy as well as X-ray short-time physics.
In the block course they learn the application of X-ray physical methods (with annually changing emphases): coherent mapping, mathematical description, applications in biophysics, molecular physics, crystallography, short-term physics, etc. (each as an introduction).
Competencies:
After successfully completing the module, students have …
gathered fundamental knowledge of the principles of generating synchrotron radiation and free electron laser radiation as well as their applications;
developed abilities in the mathematical description of X-ray diffraction on selected current examples from biophysics, molecular physics, crystallography etc.</td><td>Arbeitsaufwand:
Präsenzzeit:
56 Stunden
Selbststudium:
34 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Lecture
Inhalte:
Introduction to research with synchrotron radiation and radiation of free electron lasers: generation of radiation and characteristics of the sources, basics of accelerator physics, experimental setups (beam tubes), basics of X-ray diffraction and X-ray spectroscopy, X ray short-time physics.</td><td>SWS</td></tr>
<tr><td>Lehrveranstaltung: Block course Desy Campus, Hamburg (2,5 Days)
Inhalte:
Introduction to the applications of X-ray physical methods (with annual changing emphases) using high-energy radiation:
Introduction to coherent mapping, mathematical description of X-ray imaging, applications in biophysics, molecular physics, crystallography, short-time physics, etc.</td><td></td></tr>
<tr><td>Prüfung: Mündlich (ca. 45 Minuten)
Prüfungsanforderungen:
Understanding of the basic research in physics applied to synchrotron radiation and free electron laser radiation: generation of the radiation and characteristics of the sources, basics of accelerator physics, experimental setups (beam tubes), basics of X-ray diffraction, X-ray imaging and X-ray spectroscopy; basics of X-ray short-time physics,</td><td>3 C</td></tr>
</table>

application of physical X-ray methods (with annual changing emphases): coherent mapping, mathematical description, applications in biophysics, molecular physics, crystallography, short-term physics, etc.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Introduction to X-ray physics
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Simone Agnes Techert
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 5 - 6; Master: 1 - 4
Maximale Studierendenzahl: 30	

Bemerkungen: Einbringbar in folgende Schwerpunkte: Biophysik/komplexe Systeme, Festkörper/Materialphysik

Georg-August-Universität Göttingen **Modul B.Phy.5655: Komplexe Dynamik physikalischer und biologischer Systeme** *English title: Complex dynamics of physical and biological systems*	4 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollen die Studierenden in Lage sein, sich ausgewählte Themen und Fragestellungen anhand von Publikationen in Fachzeitschriften oder Büchern zu erarbeiten und einem Vortrag vorzustellen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Komplexe Dynamik physikalischer und biologischer Systeme (Seminar)	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** aktive Teilnahme **Prüfungsanforderungen:** Nichtlineare Dynamik, Biophysik, komplexe Netzwerke, erregbare Medien, Herzdynamik, Kardiomyozyten, Datenanalyse, experimentelle Techniken (z.B. Bildgebende Verfahren).	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Biophysik / Einführung in die Physik komplexer Systeme
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** apl. Prof. Dr. Ulrich Parlitz
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 2
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module B.Phy.5656: Experimental work at large scale facilities for X-ray photons**	3 C 3 WLH
Learning outcome, core skills: The goal of this course is to acquire the competence to perform experiments at modern synchrotron sources and free-electron-laser sources (large scale facilities) in a team; this includes the theoretical and experimental preparation of such beam times, as well as the experiment itself and the data analysis; Competences: after successfully finishing this course, students should have the theoretical basis as well as the experimental abilities for performing modern X-ray experiments and should have applied their knowledge to specific examples from biophysics, soft matter physics and materials physics.	**Workload:** Attendance time: 42 h Self-study time: 48 h
Course: Lab Course *Contents*: Lab course during an x-ray beam time performed by the Institute for X-Ray Physics at a national or international source (in particular DESY, BESSY, XFEL, ESRF, SLS, NSLSII, SACLA, Diamond, Soleil, Elettra); students will already be involved in the preparation and will thus be well prepared for the experimental approach. At the x-ray source, they experience the technical/experimental as well as the theoretical part of the work; after the campaign, they learn modern methods of data analysis by direct interaction with the project leaders.	
Examination: Written report (max. 10 p.) or oral examination (approx. 30 min.) about the finished scientific project, not graded **Examination prerequisites:** Active participation at an X-ray beam time, including preparation and post-processing **Examination requirements:** Description of the scientific project, including the theoretical background and the experimental challenges and approaches; description of the data analysis and the results; discussion within the scientific context.	3 C

Admission requirements: none	**Recommended previous knowledge:** Good basic knowledge of physics (semesters 1-4) and good or very good knowledge of biophysics and x-ray optics
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster Prof. Dr. Tim Salditt
Course frequency: each semester; every semester, depending of availability of X-ray beam times	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4

Additional notes and regulations: Maximum number of students: 2/beam time; if there are more applicants than slots, participants will be selected according to their experience and knowledge

Georg-August-Universität Göttingen Module B.Phy.5658: Statistical Biophysics	6 C 4 WLH
Learning outcome, core skills: **Objectives:** The students will learn basic concepts of statistical biophysics at the molecular, cellular and population level, as well as methods for the theoretical analysis of biophysical systems. **Competences:** After successful participation in the module, students should have working knowledge of basic concepts of statistical biophysics and be able to apply them to selected problems.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Statistical Biophysics (Lecture with integrated problem sessions) *Course frequency:* each winter semester	WLH
Examination: written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Physical principles of biological systems on the molecular, cellular and population level, application of methods from statistical physics to biological and biophysical problems.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in biophysics and statistical physics
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5659: Seminar on current topics in theoretical biophysics**	4 C 2 WLH

Learning outcome, core skills: **Objectives:** The students will develop a basic understanding of current topics and methods of theoretical biophysics at the molecular, cellular and population level, based on selected examples. **Competences:** After completing this module, the students should be able to research a topic in theoretical biophysics in the scientific literature, analyse it critically and present it in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar on current topics in theoretical biophysics	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Presentation of a selected research topic and critical discussion of its methods and results	4 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in biophysics and statistical physics
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Additional notes and regulations:	

Georg-August-Universität Göttingen **Modul B.Phy.566: Seminar zu speziellen Themen der Biophysik/ komplexen Systeme** *English title: Seminar Biophysics/Complex Systems*	4 C 2 SWS
Lernziele/Kompetenzen: **Lernziele:** Umgang mit Präsentationsmedien und Präsentation komplexer Sachverhalte vor Experten und fachfremden Zuhörern, Kommunikations- und Diskussionsfähigkeit, Kritikfähigkeit und Ausdrucksfähigkeit. **Kompetenzen:** Die Studierenden sollen selbständig den Inhalt wissenschaftlicher Publikationen (in der Regel englischsprachig) aus dem Bereich der Biophysik/komplexe Systeme erarbeiten und vor einem breiten Publikum präsentieren können.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: B.Phy.566: Seminar zu speziellen Themen der Biophysik/ komplexen Systeme (Seminar)	2 SWS
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** aktive Teilnahme **Prüfungsanforderungen:** Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation aus dem Bereich der Biophysik/komplexen Systeme. 4 Wochen Vorbereitungszeit	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan/in der Fakultät für Physik
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module B.Phy.5660: Theoretical Biofluid Mechanics**	3 C 2 WLH

Learning outcome, core skills: The course will discuss the theoretical foundations of fluid mechanics used in the study of biological systems. Important concepts in the mathematical study of fluids will be introduced and employed to investigate blood flow and circulation, the propulsion of organisms and transport facilitated by fluid flow. Students will learn to set up theoretical models for a range of biological systems involving fluids employing the Navier-Stokes equation and appropriate boundary conditions. The course will prepare the students to simplify, assess and analyze models to investigate the intricate role of fluids in biological settings.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Theoretical Biofluid Mechanics (Lecture)	
Examination: Written exam (60 minutes) or oral exam (approx. 30 minutes) **Examination requirements:** Solving Navier-Stokes equation in simple geometry, derive simplified equations from models of fluid flow and transport, explore theoretical models in limiting parameter range and assess prediction in relation to modeled biological system. The exam will be oral, if max. 20 students take part at the first date of the course. Oherwise it will be a written exam.	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of calculus and algebra
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp Contact: David Zwicker
Course frequency: every 4th semester; Every second Summerterm in Rotation to Microfluidic	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 3 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5662: Active Soft Matter**	4 C 2 WLH

Learning outcome, core skills: Students acquire in depth expertise in the discipline of Active Soft Matter, focussed on artificial and biological microswimmers in experiment and theory. Topics include self-propulsion at low Reynolds numbers, chemo-, electro-, magneto- , gravi- and phototaxis, active droplets, colloids and Janus particles, dynamics of flagellae and ciliae in bacteria and algae, interaction with interfaces and complex geometries, collective and swarming dynamics and active emulsions. Core skills include the independent study of literature on current research, and the condensation, presentation and discussion of a specific topic, which are vital skills pertaining to presenting your own research and its position in a wider research field. Students will practice the critical appreciation of current research in scientific discussion and receive feedback on their presentation skills.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Active Soft Matter (Seminar)	
Examination: Oral presentation (approx. 45 min.) and handout (4 pages max.) **Examination requirements:** Preparation, presentation and discussion of a current topic in active soft matter based on published literature. Active engagement in discussions on other student's presentations. Handouts must be submitted before the presentation.	4 C

Admission requirements: none	**Recommended previous knowledge:** introductory hydrodynamics and thermodynamics
Language: English, German	**Person responsible for module:** Prof. Dr. Stephan Herminghaus
Course frequency: every 3rd semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 26	

Additional notes and regulations: Contact: Dr. Oliver Bäumchen, Dr. Corinna Maaß,

Georg-August-Universität Göttingen **Module B.Phy.5664: Excursion to DESY and the European XFEL, Hamburg**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning goals: Basic knowledge about mission of large scale reasearch facilities, user concept and mission of DESY and European Free-electron laser (XFEL). Basic concepts of modern accelerators (super conducting and conventional), generation of synchrotron and FEL radiation, and fields of applications. **Competencies:** Overview about research and career opportunities at DESY and XFEL and how large scale facilities can be used for research and study topics. Categorize interdisciplinary information gathered at the excursion (presentations, poster session, workshop) and place it in perspective with own study background.	Attendance time: 28 h Self-study time: 62 h

Course: Excursion to DESY and the European XFEL, Hamburg (Excursion)	
Examination: oral presentation of one of the scientific activities at DESY (approx. 20min+10min discussion), Poster on a corresponding research topic, or approx. 4 pages contribution to the excursion protocol., not graded **Examination prerequisites:** Participation in the excursion and discussion of prepared lerning material **Examination requirements:** Basic knowledge about mission of large scale reasearch facilities, user concept and mission of DESY and European Free-electron laser (XFEL). Basic concepts of modern accelerators (super conducting and conventional), generation of synchrotron and FEL radiation, and fields of applications.	3 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5625: Röntgenphysik
Language: English, German	**Person responsible for module:** Prof. Dr. Tim Salditt Prof. Dr. Sarah Köster
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 10	

Georg-August-Universität Göttingen Module B.Phy.5665: Processing of Signals and Measured Data	3 C 2 WLH
Learning outcome, core skills: **Learning outcome**: • Errors, e.g. systematic vs. random, static vs. dynamic, error propagation • Extraction of relevant information (separating trends, stochastic data and affecting influences, such as noise) • Stationarity, statistical quantities and functions • Characteristics of estimators (e.g., sufficiency, ergodicity, bias freeness, efficiency), Cramer-Rao bound, Bessel's correction • Sampling (equidistant and non-uniform), Possibility of reconstruction, sampling theorem, aliasing • Signal transformations (e.g. cosine, Fourier, Hilbert, Laplace, wavelet, z transform) and signal decomposition (e.g. Proper Orthogonal Decomposition, Independent Component Analysis) • Correlation functions and spectra, Wiener-Khinchin theorem • preferred acquisition, sample weighting • Window functions, moving average **Core skills**: • Specification of a measurement (sampling rate, duration, amount of data) • Bias-free and most efficient signal and data processing of measured data • Programming in Matlab or Python	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Processing of Signals and Measured Data	2 WLH
Examination: Presentation or oral exam (ca. 30 Min.) **Examination requirements:** Efficient use of signal and image processing methods as well as statistical analysis methods.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5666: Molecules of Life – from statistical physics to biological action**	4 C 2 WLH

Learning outcome, core skills: After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk to a wide audience. They should be also able to evaluate it critically.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Molecules of Life – from statistical physics to biological action (Seminar)	
Examination: Presentation, Bachelor approx. 30 min; Master approx. 60 min	4 C

Admission requirements: none	**Recommended previous knowledge:** • Thermodynamik und statistische Mechanik and/or • Introduction to Biophysics and/or • Introduction to Physics of Complex Systems and/or • Theoretical and Computational Biophysics and/or • Biomolecular Physics and Simulations
Language: English, German	**Person responsible for module:** Hon.-Prof. Dr. Karl Helmut Grubmüller Bert de Groot, Aljaz Godec
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 15	

Georg-August-Universität Göttingen **Module B.Phy.5669: Seminar on Living Matter Physics**	4 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning objectives: The seminar is a combination of presentations by external speakers and journal club presentations by students. The students will learn about state-of-the-art theoretical and experimental research in the physics of biological and biomimetic systems, as delivered by the invited speakers in the weekly seminars of the Department of Living Matter Physics of the MPI for Dynamics and Self-Organization. Seminars will be on a wide range of topics such as biological and artificial micro-swimmers and molecular motors; collective behaviour in cellular tissues, bacterial colonies, and dense active materials; chemical activity and self-organization at the sub-cellular scale; the physics of cellular and biomimetic membranes; or information flow and stochastic thermodynamics in living systems. The students will also learn how to conduct research, prepare and deliver journal club presentations about recently published articles in these topics. **Competences**: This course will give students a broad view of the latest research on the physics of living matter, and acquaint them with how practicing researchers communicate scientific findings to each other.	Attendance time: 28 h Self-study time: 92 h

Course: Seminar on Living Matter Physics	
Examination: One or more journal club presentations (approx. 30 mins each) depending on the number of participating students (30 minutes)	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Ramin Golestanian Dr. Jaime Agudo-Canalejo
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5670: Introduction to Magnetic Resonance Imaging**	6 C 4 WLH

Learning outcome, core skills: Introduction to magnetic resonance imaging. This includes basic knowledge about the underlying physics (e.g. nuclear spins, Larmor frequency, Zeeman effect, gyromagnetc ratio, Bloch equations, spin relaxation), technical details of an MRI scanner (e.g. static magnetic field, radio-frequency transmitter, magnetic gradient system, receiv- and transmitter coils), about acquisition and reconstruction methods and about specific medical applications (e.g. perfusion and diffusion imaging). The lecture is complemented by exercises and practical examples to strengthen the acquired knowledge.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture: Introduction to Magnetic Resonance Imaging (Lecture)	WLH
Course: Exercises: Introduction to Magnetic Resonance Imaging (Exercise)	WLH
Examination: Written exam (120 min.), oral exam (ca. 30 min.), or practical project with presentation (ca. 20 min) and written report (10 pages max.), 4 weeks of preparation time **Examination requirements:** Basic knowledge about magnetic resonance imaging (physics, MRI scanner, data acquisition, reconstruction, and applications)	6 C

Admission requirements: none	**Recommended previous knowledge:** Electrodynamics, quantum mechanics
Language: English, German	**Person responsible for module:** Prof. Dr. Tim Salditt Prof. Dr. Uecker, Prof. Dr. Boretius
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module B.Phy.5671: Dynamics of living systems**	3 C 4 WLH

Learning outcome, core skills: The student will learn to simulate the dynamical changes observed in different living systems. Typically these systems have been already published in classical papers that develop simulations. These simulations will be reproduced as part of the course project. During the course we will use known system to translate biological functions to the underlying biochemistry. The biochemistry in turn is converted to rate equations, which typically form a system of coupled nonlinear differential equations that cannot be solved analytically. Using simple numerical approaches the students will simulate these systems to recover the behavior observed in the real, living systems. Typical examples are oscillations, pattern formations and bifurcations. The student will be able to model biological signaling cascades and diffusion problems by simple numerical approaches. This will train interdisciplinary skills, understanding of basic biological concepts, integration of physics, biology, chemistry and math. The problems are solved in groups of 2 training communication skills. Furthermore, critical analysis of the already published simulations will help understanding the strength and pitfalls of simulations in biology.	**Workload:** Attendance time: 56 h Self-study time: 34 h

Course: Lecture: Dynamics of Living Systems (Lecture)	1 WLH
Course: Computer Lab Course: Dynamics of Living Systems (Internship)	3 WLH
Examination: Oral presentation (ca. 30 min. including ca. 10 min. discussion), short report (max. 20 pages) on the project. **Examination prerequisites:** Active participation (computer lab). Generation of a running simulation. **Examination requirements:** The project prepared during the semester will be presented to the other students, hence all students have to be present during the presentations. A short report (15-20 pages) describing the project and the generated code, including a short discussion of the difficulties encountered.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Alle Prof. Betz
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 16	

Georg-August-Universität Göttingen **Module B.Phy.5672: Nonlinear Dynamics**	3 C 2 WLH

Learning outcome, core skills: After successfully finishing this course, students will know about and understand typical features of nonlinear systems. Furthermore, they will be familiar with basic and advanced concepts and methods of nonlinear dynamics and their applications in physics and other fields of science. In particular, students will be able to implement suitable numerical algorithms or use existing software to simulate complex and chaotic dynamical processes and to perform different forms of analyses (stability and bifurcation analysis, time series analysis and prediction, control and synchronization, estimation of fractal dimension(s), computation of Lyapunov spectra, network analysis, ..).	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Workshop and Lecture Nonlinear Dynamics	2 WLH
Examination: Oral exam (ca. 30 min.) or written exam (60 min.) or presentation (ca. 30 min, 2 weeks preparation time) **Examination requirements:** Knowledge of different topics and concepts in nonlinear dynamics covered in the course and understanding how to apply them to investigate, simulate and analyse dynamical systems, in particular using numerical tools.	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in physics; linear algebra and calculus; programming skills
Language: English, German	**Person responsible for module:** apl. Prof. Dr. Ulrich Parlitz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen Module B.Phy.5673: Cell Mechanics	6 C 4 WLH
Learning outcome, core skills: **Learning outcome:** Basics in elasticity theory and fluid dynamics, viscoelastic materials, soft matter, polymers and complex filaments, 2D and 3D networks, passive and active microrheology, fluctuations dissipation theorem, bio membranes, membrane undulations, intermembrane and electrostatic forces, simplified cells and vesicles, dynamic filaments, growth and division, traction forces, mechanosensing, Life in crowded environments, 2D tissue dynamics, jamming, 3D tissue dynamics, mechanics in development **Core skills:** The core goal is to give a deep overview of the adaptive mechanics and coordinated force generation used by cells and cellular systems to perform various complex functions. We will focus on a deep physics understanding, coming from fundamental physical laws that are rooted in conservation laws and statistical physics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture and self-studies using literature: Cell Mechanics	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Derivation of fundamental mechanics properties, including viscoelasticity, modelling of polymers and biopolymers, microrheology, membrane mechanics, 2D and 3D networks.	6 C

Admission requirements: None	**Recommended previous knowledge:** Introduction to Biophysics
Language: German, English	**Person responsible for module:** Prof. Dr. Timo Betz
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen Module B.Phy.5674: Modern Image Processing	3 C 2 WLH
Learning outcome, core skills: **Learning outcome:** Enabling the student to extract meaningful data from scientific images using self-written Python programs. The syllabus starts with standard techniques of image processing and ends with more recent developments coming from the field of machine learning. This is a hands-on course; a significant part of the time will be used for coding exercises. **Core skills:** Concepts covered include: image acquisition, intensity transfomations, color, spatial and morphological filters, image registration, feature extraction, Fast Fourier Transform, segmentation, Convolutional Neural Networks, autoencoder, semantic segmentation, surface models, tomography, stereo vision.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Lecture Modern Image Processing with in-class exercises and homework	
Examination: Oral Presentation (approx. 30 minutes) **Examination requirements:** An image processing project, demonstrating mastery of the concepts taught in this course	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** PD Dr. Matthias Schröter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5675: Machine Learning, hands-on**	4 C 3 WLH

Learning outcome, core skills: **Learning outcome:** Enabling the student to apply machine learning algorithms to solve scientific problems using self-written Python programs. The syllabus covers both more traditional techniques and deep neural networks. This is a hands-on course, a significant part of the time will be used for coding exercises. **Core skills:** Concepts covered include: data preprocessing, linear regression, regularization, logistic regression, Bayesian reasoning in ML, Gaussian Mixture Models, decision trees, random forests, support vector machines, clustering, principal component analysis, deep neural networks, convolutional neural networks, (variational) autoencoders, natural language processing, ethics and ML.	**Workload:** Attendance time: 42 h Self-study time: 78 h

Course: Machine Learning, hands-on *Contents*: Lecture with in-class exercises and homework	3 WLH
Examination: Oral examination (approx. 30 minutes) **Examination prerequisites:** At least 70% of the homework points. **Examination requirements:** a machine learning project, demonstrating mastery of the concepts taught in this course	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Klumpp PD Dr. Matthias Schröter
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 28	

Georg-August-Universität Göttingen Module B.Phy.5676: Computer Vision and Robotics	9 C 6 WLH
Learning outcome, core skills: After successful completion of this module, students are familiar with • the basic concepts of computer vision (CV), • low level hardware components and their functions, • building and programming a robot, and • computer vision and robotics algorithms.	**Workload:** Attendance time: 84 h Self-study time: 186 h
Course: Introduction to Computer Vision and Robotics (Lecture) *Contents*: On-Off Controller, PID Controller, Moving Average Filter, Exponential Moving Average Filter, Kalman Filter, A*, Dijkstra, RRT, Q-Learning , Inverse and Forward Kinematics, Movement Generation Methods, Smoothing and Median Filtering, Bilateral Filtering, Non-Local Means, Connected Components , Morphological Operators , Line Detection, Circle Detection, Feature Detection, Advanced image segmentation algorithms.	2 WLH
Course: Practical Course on Computer Vision and Robotics (Lecture) *Contents*: Building a robot, solving a graph problem using the robot and executing the found solution by the robot in a real-world scenario involving perception and navigation	2 WLH
Course: Tutorial on Computer Vision and Robotics (Tutorial) *Contents*: In the accompanying tutorial sessions students deepen and broaden their knowledge from the lectures	2 WLH
Examination: Written report (approx. 10 p.) and Oral Exam (approx. 30 minutes) **Examination requirements:** Written report requirements: The students must be able • to describe their project in a written report • to explain given problems and used solutions for navigation- and perception problems of robots Oral Examination requirements: The students must be able • to repeat and explain lecture material • to explain control algorithms for a robot, and • to identify and understand low level hardware components as robot sensors and actuators.	9 C

Admission requirements: none	**Recommended previous knowledge:** Programming in Python
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

three times	Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 24	

Georg-August-Universität Göttingen **Module B.Phy.5677: Seminar on Advanced Topics in Cellular Biophysics**	4 C 2 WLH

Learning outcome, core skills: The aim of this course is for students to gain a profound knowledge in a selection of the following topics in cellular biophysics: - Cell studies (“top-down”) - In vitro experiments (“bottom-up”) - Cytoskeleton - Biopolymers and networks - Cell mechanics - Cell dynamics - Cell adhesion - Cell motility - Force generation in biological systems After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar on Advanced Topics in Cellular Biophysics	
Examination: Presentation with scientific discussion (ca. 30 min.) and scientific discussion with the other participants **Examination requirements:** Cell studies (“top-down”), in vitro experiments (“bottom-up”), cytoskeleton, biopolymers and networks, cell mechanics, cell dynamics, cell adhesion, cell motility, force generation in biological systems	4 C

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course "Introduction to Biophysics"; Bachelor studies in physics or a related field
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5678: Seminar on Advanced Methods in Biophysics**	4 C 2 WLH
Learning outcome, core skills: The aim of this course is for students to gain a profound knowledge in a selection of the following methods and their applications in biophysics: - Imaging: Fluorescence microscopy, x-ray imaging, x-ray scattering, atomic force microscopy - Force measurements: optical tweezers, atomic force spectroscopy, traction force microscopy - Modelling After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar on Advanced Methods in Biophysics	
Examination: Presentation with scientific discussion (ca. 30 min.) and scientific discussion with the other participants **Examination requirements:** Fluorescence microscopy, x-ray imaging, x-ray scattering, optical tweezers, atomic force microscopy and spectroscopy, modelling: methods and applications in biophysics	4 C

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course "Introduction to Biophysics"; Bachelor studies in physics or a related field
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen Module B.Phy.5679: Cell Biology Methods for Physicists	3 C 2 WLH

Learning outcome, core skills:	Workload:
Learning outcome The aim of this course is for students to gain a profound theoretical and practical knowledge in the cell biology methods that are used in cell biophysics. Topics covered are: • Working in a sterile environment • E. coli transformation for DNA amplification, purification and sequence analysis, • Mammalian cell passaging and transfection • Cell fixation and antibody staining • Imaging by epifluorescence microscopy • Image processing. **core skills** After successfully completing this course, students will be able to • plan and perform cell biology experiments • understand and interpret microscopy images of cells	Attendance time: 28 h Self-study time: 62 h

Course: Cell Biology Methods for Physicists (Practical course)	2 WLH
Examination: written report (max. 10 pages) **Examination requirements:** Proficiency in: • Working in a sterile environment • E. coli transformation for DNA amplification, purification and sequence analysis, • Mammalian cell passaging and transfection • Cell fixation and antibody staining • Imaging by epifluorescence microscopy • Image processing	3 C

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course *Introduction to Biophysics*; Bachelor studies in physics or a related field (is useful, but not necessary)
Language: English, German	**Person responsible for module:** Prof. Dr. Sarah Köster Contact person: Dr. Ulrike Rölleke
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 3 - 6; Master: 1 - 4
Maximum number of students:	

3	

Georg-August-Universität Göttingen Module B.Phy.5680: Biophysics across scales	6 C 4 WLH

Learning outcome, core skills: **learning outcome**: The aim of this course is for students to gain a profound knowledge in the following fields: • Basics in biology and chemistry (cellular components, physical chemistry, molecular biology); • Basics in soft matter physics (Random walks, Brownian motion, diffusion; polymer physics); • Methods (microscopy, scattering, optical tweezers, atomic force microscopy, microfluidics); • Biophysics across scales (structural biology – molecular scale; filaments and membranes – mesoscopic scale; active matter – mesoscopic scale; cellular scale, tissue and organ scale) **core skills:** After successfully completing this course, students will be able to • extract relevant information from scientific publications • plan biophysical experiments • analyze, plot and interpret model data sets • understand, solve and interpret physical models of biological systems • discuss state-of-the-art biophysics research results	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Biophysics across scales (Lecture)	3 WLH
Examination: Oral exam (approx. 30 min.) or written exam (60 min.) **Examination requirements:** Proficiency in: • Basics in biology and chemistry (cellular components, physical chemistry, molecular biology); • Basics in soft matter physics (Random walks, Brownian motion, diffusion; polymer physics); • Methods (microscopy, scattering, optical tweezers, atomic force microscopy, microfluidics); • Biophysics across scales (structural biology; filaments and membranes; active matter; cells, cell ensembles and tissues)	6 C

Course: Biophysics across scales: hands-on-tutorial	1 WLH

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course *Introduction to Biophysics*; Bachelor studies in physics or a related field
Language:	**Person responsible for module:**

English	Prof. Dr. Sarah Köster
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4

Georg-August-Universität Göttingen **Module B.Phy.5681: Seminar CARA: Critical analysis of research articles of cell and tissue mechanics**	4 C 2 WLH

Learning outcome, core skills: After successfully finishing this course, students will be able to critically read a research paper on the subject of cell and tissue mechanics. They will be able to present such subjects in detail by identifying strengths and weaknesses. This will be done on articles that are currently only on the preprint servers. In the second part, the participants will prepare a brief presentation if a second paper where they learn how to efficiently transmit the highlights of a recent research paper. Master students and if interested also Bachelor students will practice the skill of Peer-Reviewing a paper by writing such a peer review of the paper they had presented in more detail.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar CARA (Seminar)	2 WLH
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Soft matter, cell mechanics, rheology, tissue mechanics, active systems, membranes, cell motility	

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: English	**Person responsible for module:** Prof. Dr. Timo Betz
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5682: Seminar: Special Topics in Cell Mechanics**	4 C 2 WLH
Learning outcome, core skills: The aim of this course is for students to gain profound knowledge in a selection of the following topics in cellular biophysics: • Biopolymers • Soft Matter • Active and Passive Rheology • Cell mechanics • Cell dynamics • Cell motility • Force generation in biological systems This will be done by presenting a short research project that will be performed in the context of the course. After successfully finishing this course, students will be able to work out or reproduce a specific question with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar: Special Topics in Cell Mechanics (Seminar)	2 WLH
Examination: Presentation with a scientific discussion of a research project on the subject of cell mechanics (approx. 45 min.) **Examination prerequisites:** Active participation **Examination requirements:** Biopolymers, Soft Matter, Active and Passive Rheology, Cell mechanics, Cell dynamics, Cell motility, Force generation in biological systems.	

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: English	**Person responsible for module:** Prof. Dr. Timo Betz
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Modul B.Phy.5702: Dünne Schichten** *English title: Thin Layers*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden Begriffe der Physik dünner Schichten und Schichtstrukturen anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung mit Seminar (je zur Hälfte)	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** Aktive Teilnahme im Seminar	3 C
Prüfungsanforderungen: Oberflächen; UHV; Dünnschichtverfahren; Keimbildung und Wachstum dünner Schichten; Epitaxie; Untersuchungsmethoden; spezielle Eigenschaften dünner Schichten.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 4
Maximale Studierendenzahl: 24	

Georg-August-Universität Göttingen **Modul B.Phy.5707: Nanoscience** *English title: Nanoscience*	3 C 2 SWS

Lernziele/Kompetenzen: **Lernziele**: Electronic properties of electrons confined in low-dimensional nanostructures (2D, 1D and 0D). Experimental methods for the preparation and characterization of nanostrucures. Semiconductor materials will be on focus. **Kompetenzen**: After successful completion of the modul the students should be able to gain a knowledge basis of the relevant concepts and methods needed when dealing with nanostructures.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Vorlesung	
Prüfung: Mündliche Prüfung oder Vortrag (je ca. 30 Min.)	3 C

Prüfungsanforderungen: The students should show a knowledge basis of the relevant concepts and methods needed when dealing with nanostructures. Student choice if in German or in English.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** • Quantenmechanik I • Einführung in die Festkörperphysik • Einführung in die Materialphysik
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Angela Rizzi
Angebotshäufigkeit: jedes 4. Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 5 - 6; Master: 1
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen Module B.Phy.5709: Seminar on Nanoscience	4 C 2 WLH
Learning outcome, core skills: **Lernziele**: Electronic properties of electrons confined in low-dimensional structures (2D, 1D and 0D). Experimental methods for the preparation and characterization of nanostrucures. Functional nanostructures. Devices in nanoelectronics. Semiconductor materials will be on focus. **Kompetenzen**: After successful completion of the modul the students should be able to gain a deep knowledge of a current topic in nanoscience and nanodevices from the recommended scientific literature. The student will present and discuss the topic in a Seminar.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar (Blockveranstaltung)	
Examination: Vortrag (ca. 30 Min.) - student choice if in German or in English **Examination prerequisites:** Aktive Teilnahme	4 C
Examination requirements: The students should achieve a deep knowledge of a current topic in nanoscience and nanodevices from the recommended scientific literature; the student should be able to transfer this knowledge to an audience in a seminar.	

Admission requirements: none	**Recommended previous knowledge:** • Einführung in die Festkörperphysik • Einführung in die Materialphysik • Quantenmechanik I • Nanoscience
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 2
Maximum number of students: 20	

Georg-August-Universität Göttingen **Modul B.Phy.571: Spezielle Themen der Festkörper- und Materialphysik I** *English title: Specific topics of solid state and materials physics I*	6 C 6 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren sollten die Studierenden aktuelle Forschungsthemen der Festkörper-/Materialphysik verstehen und bewerten können. Sie sollten ihr Grundlagenwissen über Methoden und Modelle vertieft haben.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Veranstaltung aus dem Lehrangebot der Festkörper- und Materialphysik	
Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit)	

Prüfungsanforderungen: Vertiefung der in den Einführungsveranstaltungen angeeigneten Kenntnisse in Festkörper-/Materialphysik. Aktuelle Forschungsthemen der Festkörper-/Materialphysik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Module B.Phy.5714: Introduction to Solid State Theory**	6 C 6 WLH

Learning outcome, core skills: **Lernziele:** Fundamental concepts of of solid state theory, Born-Oppenheimer approximation, homogeneous electron gas, electrons in lattices, lattice vibrations, elementary transport theory **Kompetenzen:** After successful completion of the modul students should be able to describe and calculate fundamental properties of solids; understand and use the language of solid-state theory.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: lecture	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Application of fundamental concepts in solid state theory, interpretation of basic experimental observations, theoretical description of fundamental phenomena in solid state physics.	6 C

Course: exercises	2 WLH

Admission requirements: keine	**Recommended previous knowledge:** Quantum mechanics I
Language: German, English	**Person responsible for module:** Prof. Dr. Stefan Kehrein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5716: Nano-Optics meets Strong-Field Physics**	6 C 4 WLH

Learning outcome, core skills: At the end of the course, students should understand and be able to apply the basic concepts of nano-optics and strong-field physics, as well as their connection in modern research. In the accompanying exercises, numerical simulations will be developed which build on the topics discussed in the lectures. An introduction will be given to scripting in Matlab and to finite element simulations with Comsol Multiphysics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Vorlesung	2 WLH
Course: Übung	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination prerequisites:** Implementation of a task in an executable programme.	6 C

Admission requirements: none	**Recommended previous knowledge:** Experimentalphysik I-IV, Quantenmechanik
Language: German, English	**Person responsible for module:** Prof. Dr. Claus Ropers StudiendekanIn der Fakultät für Physik
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5717: Mechanisms and Materials for Renewable Energy**	6 C 4 WLH
Learning outcome, core skills: By participation in both lectures on photovoltaics and solar thermal energy, thermoelectrics and solar fuels students gain knowledge about the full spectrum of physical and chemical basics of renewable energy conversion. In addition, overlapping aspects of fundamental concepts and technological approaches have been reviewed. Students shall independently apply gained knowledge to acquire and present current research in the field.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Mechanismen und Materialien für erneuerbare Energien (Lecture)	
Examination: Poster presentation with oral examination (approx. 30 Min.) **Examination requirements:** Beherrschung der grundlegenden Begriffe, Fakten und Methoden. Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics, Introduction to materials physics
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt Prof. Dr. Christian Jooß
Course frequency: two-year as required, summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen Module B.Phy.5718: Mechanisms and Materials for Renewable Energy: Photovoltaics	4 C 2 WLH
Learning outcome, core skills: After successful completion of this module students are familiar with physical basics or photo-electric energy conversion, are able to apply fundamental concepts and gained knowledge about important materials systems of photovoltaics. In addition, important experimental methods as well as current and future technological concepts have been reviewed. Students shall independently apply gained knowledge to acquire and present current research in the field.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Mechanismen und Materialien für erneuerbare Energien: Photovoltaik (Lecture)	
Examination: Poster presentation with oral examination (approx. 30 Min.) **Examination requirements:** Beherrschung der grundlegenden Begriffe, Fakten und Methoden. Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics, Introduction to Materials physics
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt
Course frequency: zweijährig im SoSe	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5719: Mechanisms and Materials for Renewable Energy: Solar heat, Thermoelectric, solar fuel**	4 C 2 WLH
Learning outcome, core skills: Physical and chemical basics of light and heat conversion to electrical and chemical energy. • In particular:Mechanisms of solarthermic, thermoelectric, electro- and photochemical energy conversion. • Important model systems and materials. • Outlook in current research activities. Students shall independently apply gained knowledge to acquire and present current research on relevant systems.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Mechanismen und Materialien für erneuerbare Energien: Solarthermie, Thermoelektrik, solarer Treibstoff (Lecture)	
Examination: Posterpresentation with oral examination (approx. 30 Min.) **Examination requirements:** Beherrschung der grundlegenden Begriffe, Fakten und Methoden. Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics, Introduction to Materials Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Christian Jooß
Course frequency: two-year as required, summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.572: Spezielle Themen der Festkörper- und Materialphysik II** *English title: Specific topics of solid states and materials physics II*	6 C 6 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren sollten die Studierenden aktuelle Forschungsthemen der Festkörper-/Materialphysik verstehen und bewerten können. Sie sollten ihr Grundlagenwissen über Methoden und Modelle vertieft haben.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Veranstaltung aus dem Lehrangebot der Festkörper- und Materialphysik IIa	3 SWS
Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit)	3 C

Lehrveranstaltung: Veranstaltung aus dem Lehrangebot der Festkörper- und Materialphysik IIb	3 SWS

Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit)	3 C

Prüfungsanforderungen: Vertiefung der in den Einführungsveranstaltungen angeeigneten Kenntnisse in Festkörper-/Materialphysik. Aktuelle Forschungsthemen der Festkörper-/Materialphysik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 2 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Module B.Phy.5720: Introduction to Ultrashort Pulses and Nonlinear Optics**	3 C 2 WLH

Learning outcome, core skills: After successful completion of this Module students will be able to work with advanced concepts, phenomena and models of ultrashort pulses and their applications in nonlinear optics.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Introduction to Ultrashort Pulses and Nonlinear Optics (Lecture)	
Examination: Oral (approx. 30 min.) or written (90 min.) **Examination requirements:** Matter-light interaction; rate equations; continuous and pulsed laser operation; mode coupling; properties of ultrashort pulses; nonlinear susceptibility and nonlinear response of bound electrons; frequency doubling; parametric amplification; self-focusing; self-phase modulation; high-harmonic generation	3 C

Admission requirements: none	**Recommended previous knowledge:** • Elektrodynamic (Experimentalphysics II) • Optic and waves (Experimentalphysics III)
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Dirk Mathias
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen Module B.Phy.5721: Information and Physics	6 C 6 WLH
Learning outcome, core skills: Understanding the concept of information in classical physics and quantum physics, in depth understanding of the second law of thermodynamics and its generalizations with the Landauer erasure principle, learning key elements of quantum information theory and quantum computation	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Information and Physics (Lecture, Exercise)	
Examination: Written examination (120 minutes) **Examination requirements:** Understanding the concepts of classical and quantum information science, performing calculations in classical and quantum information science and interpreting the results	6 C

Admission requirements: none	**Recommended previous knowledge:** Analytical Mechanics, Quantum Mechanics and Statistical Physics
Language: English	**Person responsible for module:** Prof. Dr. Stefan Kehrein
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen Module B.Phy.5722: Seminar on Topics in Nonlinear Optics	4 C 2 WLH
Learning outcome, core skills: This seminar adresses some of the most important nonlinear optical phenomena and their application. Exemplary topics will be parametric processes and wave mixing, high harmonic generation, spatial and temporal solitons, supercontinuum generation, optical phase conjugation, stimulated Raman scattering, photorefractive phenomena, optical filamentation and electromagnetically induced transparency.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar on Topics in Nonlinear Optics (Seminar)	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** compulsory attendance **Examination requirements:** A fundamental understanding of nonlinear optical phenomena and their application.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Claus Ropers
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5723: Hands-on course on Density-Functional calculations 1**	3 C 3 WLH
Learning outcome, core skills: Students will be able to perform first-principles electronic-structure and ab-initio molecular dynamics simulations, understand the results and judge their accuracy. They will have a basic knowledge of the underlying methods. They will know simple methods of anticipating and describing electronic and atomic structure and chemical bonds.	**Workload:** Attendance time: 40 h Self-study time: 50 h

Course: Hands-on course on Density-Functional calculations 1 (Block course) *Contents*: 1. Theoretical foundation of first-principles calculations (lecture 10 h) 2. Simple concepts of electronic structure and chemical binding (lecture 10 h) 3. Hands on Course with the CP-PAW code (Exercise 20 h)	
Examination: oral (approx 30 min), presentation (30 min) or report **Examination prerequisites:** regular participation **Examination requirements:** The student is able to describe topics from the course and to respond to questions. A presentation or a report will describe a specified home project.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Bloechl
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5724: Hands-on course on Density-Functional calculations 1+2**	6 C 6 WLH

Learning outcome, core skills: Students will be able to perform first-principles electronic-structure and ab-initio molecular dynamics simulations, understand the results and judge their accuracy. They will have a basic knowledge of the underlying methods. They will know simple methods of anticipating and describing electronic and atomic structure and chemical bonds.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Hands-on course on Density-Functional calculations 1+2 (Block course) *Contents*: 1. Theoretical foundation of first-principles calculations (lecture 10 h) 2. Simple concepts of electronic structure and chemical binding (lecture 10 h) 3. Hands on Course with the CP-PAW code (Exercise ~22 h) 4. Advanced topics of first-principles calculations (lecture ~8 h) 5. Hands on Course: guided projects (~26 h) 6. Seminar on guided projects (~12 h)	
Examination: oral (approx 30 min), presentation (30 min) or report **Examination prerequisites:** regular participation **Examination requirements:** The student is able to describe topics from the course and to respond to questions. A presentation or a report will describe a specified project.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Bloechl
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5725: Renormalization group theory and applications**	6 C 6 WLH

Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand concepts of field theory and renormalization group in classical and quantum systems. **Core skills:** Students will be able to use the basics of field theory, including perturbation theory and renormalization, and be able to apply these tools to physical problems.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Renormalization group theory and applications (Lecture)	4 WLH
Course: Renormalization group theory and applications (Exercise)	2 WLH
Examination: Written or oral examWritten exam (120 min) or oral exam (approx. 30 min) **Examination prerequisites:** None **Examination requirements:** Theoretical concepts of field theory, renormalization techniques, and their physical interpretation.	6 C

Admission requirements: none	**Recommended previous knowledge:** • Thermodynamik und statistische Mechanik • Quantenmechanik I
Language: English, German	**Person responsible for module:** Prof. Dr. Matthias Krüger
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Modul B.Phy.5726: Kinetik und Phasenumwandlung in Materialien** *English title: Kinetics and phase transformation in materials*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden Begriffe der Nicht-Gleichgewicht-Prozesse und des Transports auf materialphysikalische Fragestellungen anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung mit Übung	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	3 C
Prüfung: Mündlich (ca. 30 Minuten)	3 C
Prüfungsanforderungen: Analytische Verfahren zur Vereinfachung und Lösung nicht-linearer partieller Differentialgleichungen. Nicht-Gleichgewichts Thermodynamik; Transport; Diffusion; Klassifizierung von Phasenumwandlungen; Grenzflächenbewegung; morphologische Instabilitäten; Keimbildung; Wachstum; spinodale Entmischung; kinetische Umwandlungen	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Festkörperphysik Einführung in die Materialphysik
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Prof.in Cynthia Ann Volkert
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 4
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Phy.576: Seminar zu speziellen Themen der Festkörper-/ Materialphysik** *English title: Seminar Solid State/Materials Physics*	4 C 2 SWS
Lernziele/Kompetenzen: **Lernziele:** Umgang mit Präsentationsmedien und Präsentation komplexer Sachverhalte vor Experten und fachfremden Zuhörern, Kommunikations- und Diskussionsfähigkeit, Kritikfähigkeit und Ausdrucksfähigkeit. **Kompetenzen:** Die Studierenden sollen selbständig den Inhalt wissenschaftlicher Publikationen (in der Regel englischsprachig) aus dem Bereich der Festkörper-/ Materialphysik erarbeiten und vor einem breiten Publikum präsentieren können.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: B.Phy.576: Seminar zu speziellen Themen der Festkörper-/ Materialphysik (Seminar)	2 SWS
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** aktive Teilnahme **Prüfungsanforderungen:** Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation aus dem Bereich der Festkörper-/Materialphysik. 4 Wochen Vorbereitungszeit	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan/in der Fakultät für Physik
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module B.Phy.5805: Quantum field theory I**	6 C 6 WLH

Learning outcome, core skills: **Acquisition of knowledge:** Quantization of free relativistic wave equations (Klein-Gordon and Dirac); General properties of quantum fields; Interaction with external sources; Perturbation theory and basics of renormalization theory; Quantum Electro Dynamics and abelian gauge symmetry. **Competencies:** The students shall be familiar with the basic concepts and methods of Quantum Field Theory. They can apply them to explicit examples.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Quantum field theory I (Lecture)	4 WLH
Course: Quantum field theory I (Exercise)	2 WLH

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examination (120 minutes) **Examination requirements:** Solution of concrete problems treated in the lecture course. Explanation of notions and methods of Quantum Field Theory.	6 C
Examination: Oral examination (approx. 30 minutes)	6 C

Admission requirements: none	**Recommended previous knowledge:** Quantum mechanics I, II, Classical Field theory
Language: English	**Person responsible for module:** apl. Prof. Dr. Karl-Henning Rehren
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module B.Phy.5807: Physics of particle accelerators**	3 C 3 WLH
Learning outcome, core skills: After successful completion of this module, students should be familiar with the concepts, the physics (mainly electromagnetism) and explicit examples of historic and modern particle accelerators. Ideally, they should be able to simulate beam optics via numerical simulations (MatLab/SciLab).	**Workload:** Attendance time: 42 h Self-study time: 48 h
Course: Physics of particle accelerator (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Introduction to physics of particle accelerators; synchrotron radiation; linear beam optics; injection and ejection; high-frequency system for particle acceleration; radiation effects; luminosity, wigglers and undulators; modern particle accelerators based on the examples HERA, LEP, Tevatron, LHC, ILC and free electron laser FLASH/XFEL.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; unregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5808: Interactions between radiation and matter - detector physics**	3 C 3 WLH
Learning outcome, core skills: After successful completion of this module, students should be familiar with a conceptional understanding of different particle detectors and the underlying interactions. They should be familiar with physics processes of particle or radiation detection in high energy physics and related fields and applications.	**Workload:** Attendance time: 42 h Self-study time: 48 h
Course: Interactions between radiation and matter - detector physics (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Mechanism of particle detection; interactions of charged particles and photons with matter; proportional and drift chambers; semiconductor detectors; microstrip and pixel detectors; Cherenkov detectors; transition radiation detectors; scintillation (organic crystals and plastic scintillators); electromagnetic calorimeter; hadron calorimeter.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Modul B.Phy.581: Spezielle Themen der Kern- und Teilchenphysik I** *English title: Special topics of particle physics I*	6 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren sollten die Studierenden aktuelle Forschungsthemen der Kern-/Teilchenphysik verstehen und bewerten können. Sie sollten ihr Grundlagenwissen über Methoden und Modelle vertieft haben.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Veranstaltung aus dem Lehrangebot der Kern- und Teilchenphysik	
Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit)	
Prüfungsanforderungen: Vertiefung der in den Einführungsveranstaltungen angeeigneten Kenntnisse in Kern-/Teilchenphysik. Aktuelle Forschungsthemen der Kern-/Teilchenphysik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen Module B.Phy.5810: Physics of the Higgs boson	3 C 3 WLH
Learning outcome, core skills: After successful completion of this module, students should possess a deep understanding of the Higgs mechanism, the properties of the Higgs boson, and experimental methods (concepts and concrete examples) used in investigations of the Higgs sector.	**Workload:** Attendance time: 42 h Self-study time: 48 h
Course: Physics of the Higgs boson (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Review of the Standard Model of particle physics; The Higgs mechanism and the Higgs potential; properties of the Standard Model Higgs boson; Experimental methods in the search for the Higgs boson at LEP, Tevatron and LHC; Discovery of the Higgs boson; Measurement of the Higgs boson couplings and other properties; Two Higgs Doublet Modells and extended Higgs sectors (in particular, the MSSM); Searches for Higgs bosons beyond the Standard Model.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5811: Statistical methods in data analysis**	3 C 3 WLH

Learning outcome, core skills: After successful completion of this module, students should be well-versed in the theoretical foundations of statistical methodology used in data analysis. This is complemented with concrete examples where statistical analysis is performed using the ROOT software package (a free C++ type software package for data analysis, which runs on Linux, Windows, and Mac operating systems).	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Statistical methods in data analysis (Lecture)	
Examination: oral exam (approx. 30 min.) or written exam (120 min.) **Examination requirements:** Concepts, methods, can concrete examples of statistical methods in data analysis: Introduction and description of data; theoretical probability density functions, including Gaussian, Poisson, and multi-dimensional distributions; parameter estimation; maximum likelihood method (and examples); chi^2 method and chi^2-distribution; optimization; hypothesis tests; classification methods; Monte Carlo methods; unfolding.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5812: Physics of the top-quark**	3 C 3 WLH

Learning outcome, core skills: Learning Objectives and Competencies: After successful completion of this module, students should be familiar with the properties and interactions of the top-quark as well as the experimental methods for its studies.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Physics of the top-quark (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Concepts and specific experimental methods for the discovery and studies of the top-quark. Introduction to particle physics of quarks, discovery of the top-quark, top-antitop production (theory and experiment); electroweak production of single-top quarks; top-quark mass; electric charge and spin of top-quarks; W-helicity in top-quark decay; top-quark decay in the standard modell and beyond; sensitivity to new physics; top-quark physics at the ILC, recent results of top-quark physics.	3 C

Admission requirements: keine	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.5815: Seminar zu einführenden Themen der Teilchenphysik** *English title: Seminar on Introductory Topics in Particle Physics*	4 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden anhand von Publikationen oder Buchkapiteln sich in Fragestellungen zu Themen der modernen Elementarteilchenphysik einarbeiten und in einem Seminarvortrag vorstellen können.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Seminar	
Prüfung: Vortrag (ca. 30 Min.) mit schriflticher Ausarbeitung (max. 20 S.) **Prüfungsvorleistungen:** Aktive Teilnahme **Prüfungsanforderungen:** Selbständige Erarbeitung wissenschaftlicher Sachverhalte und deren Präsentation.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Kern-/Teilchenphysik
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Arnulf Quadt
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module B.Phy.5816: Phenomenology of Physics Beyond the Standard Model**	3 C 2 WLH
Learning outcome, core skills: After successful completion of this module, students understand the shortcomings and limitations of the Standard Model of Particle Physics. Students also acquire insight into the phenomenology of physics beyond the Standard Model (BSM) at TeV energy scales, particularly from models with Supersymmetry and Extra dimensions. Students will also learn the experimental signatures of BSM phenomenology at colliders along with experimental techniques and statistical methods.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Phenomenology of Physics Beyond the Standard Model (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Review of the Standard Model of particle physics; Limitations and Shortcomings of the Standard Model; Phenomenology of Supersymmetry; Phenomenology of Extra Dimensions; Other Models with New Physics; Collider Signatures of New Physics; Statistics for Experimental Searches	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Stanley Lai
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5817: Nuclear Reactor Physics**	4 C 4 WLH
Learning outcome, core skills: After successful completion of the module students should be familiar with the physics concepts of nuclear reactors, nuclear fission and breeding, neutron kinetics, neutron diffusion and neutron balance, criticality and reactivity, delayed neutrons, temperature effects on reactivity, chemical shim and burnable poisons, fast breeders, high temperature reactors, research reactors, enrichment, nuclear fuel cycle and radioactive waste, risk management	**Workload:** Attendance time: 56 h Self-study time: 64 h
Course: Nuclear reactor physics in the field of Nuclear and Particle (Lecture)	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Physics of nuclear reactors and nuclear reactor concepts	4 C
Course: Tutorial Nuclear reactor physics in the field of Nuclear and Particle (Tutorial)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Introduction to nuclear and particle physics
Language: English, German	**Person responsible for module:** Prof. Dr. Hans Christian Hofsäss
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Modul B.Phy.582: Spezielle Themen der Kern- und Teilchenphysik II** *English title: Special topics of particle physics II*	6 C 6 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren sollten die Studierenden aktuelle Forschungsthemen der Kern-/Teilchenphysik verstehen und bewerten können. Sie sollten ihr Grundlagenwissen über Methoden und Modelle vertieft haben.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Veranstaltung aus dem Lehrangebot der Kern- und Teilchenphysik IIa	3 SWS
Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit)	3 C

Lehrveranstaltung: Veranstaltung aus dem Lehrangebot der Kern- und Teilchenphysik IIb	3 SWS

Prüfung: Klausur (120 Min.) oder mündl. Prüfung (ca. 30 Min.) oder Vortrag (ca. 30 Min., 2 Wochen Vorbereitungszeit)	3 C

Prüfungsanforderungen: Vertiefung der in den Einführungsveranstaltungen angeeigneten Kenntnisse in Kern-/ Teilchenphysik. Aktuelle Forschungsthemen der Kern-/Teilchenphysik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 2 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Modul B.Phy.586: Seminar zu speziellen Themen der Kern-/ Teilchenphysik** *English title: Seminar Particle Physics*	4 C 2 SWS
Lernziele/Kompetenzen: **Lernziele:** Umgang mit Präsentationsmedien und Präsentation komplexer Sachverhalte vor Experten und fachfremden Zuhörern, Kommunikations- und Diskussionsfähigkeit, Kritikfähigkeit und Ausdrucksfähigkeit. **Kompetenzen:** Die Studierenden sollen selbständig den Inhalt wissenschaftlicher Publikationen (in der Regel englischsprachig) aus dem Bereich der Kern-/Teilchenphysik erarbeiten und vor einem breiten Publikum präsentieren können.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: B.Phy.586: Seminar zu speziellen Themen der Kern-/ Teilchenphysik (Seminar)	2 SWS
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** aktive Teilnahme **Prüfungsanforderungen:** Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation aus dem Bereich der Kern-/Teilchenphysik. 4 Wochen Vorbereitungszeit	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiendekan/in der Fakultät für Physik
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module B.Phy.606: Electronic Lab Course for Natural Scientists**	6 C 6 WLH

Learning outcome, core skills: Learning Objectives and Competencies: After successful completion of this module, students should be familiar with • fundamental concepts and terminology of electronics • be able to handle modern electronic devices (simple devices, basic circuits) • be able to work out and conduct a scientific project within a given time window	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: B.Phy.606. Electronic lab course for natural scientists (Internship, Lecture, Exercise) 1. Lecture with excercises 2. Lab (5 Experiments) 3. Praktikum (1 Projekt)	
Examination: Presentation with discussion (approx. 30 minutes) and written elaboration (max. 10 pages) **Examination prerequisites:** At least 50% of problem sets (homework) have to be solved (passed) **Examination requirements:** 1. fundamental concepts and terminology of electronics, 2. handling of simple electronics devices, basic circuits and functional units; 3. conceptual design and realisation of projects in electronics.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 20	

Additional notes and regulations: Block course

Georg-August-Universität Göttingen **Modul B.Phy.607: Akademisches Schreiben für Physiker/innen** *English title: Academic Writing for Physicists*	4 C 2 SWS
Lernziele/Kompetenzen: **Lernziele:** In diesem Workshop erlernen Studierende Grundkompetenzen des akademischen Schreibens in den beiden Schreibtraditionen des Deutschen und Englischen. Hierfür werden unterschiedliche Textarten (z.B. wissenschaftlicher Artikel, Essay, Protokoll, Bericht) sowie akademische Teiltexte (z.B. Einleitung – Introduction) in den beiden Schreibtraditionen analysiert und miteinander verglichen. Von diesem analytisch-rezeptiven Ansatz ausgehend vertiefen die Studierenden ihre Kenntnisse, indem sie selbst akademische Texte in beiden Schreibtraditionen verfassen, hierbei wird ein Schwerpunkt auf das Schreiben englischer akademischer Texte gelegt. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden über akademische Schreibkompetenzen in englischer und deutscher Schreibtradition, Reflexionsvermögen eigener akademischer Schreibprozesse sowie Feedbackkompetenzen verfügen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Akademisches Schreiben für Physiker/innen	
Prüfung: Portfolio (max. 20 Seiten) **Prüfungsvorleistungen:** Aktive, regelmäßige Teilnahme an dem Workshop, Erledigen schriftlicher Teilleistungen	
Prüfungsanforderungen: Verfassen deutscher und englischer wissenschaftlicher Texte	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Phy.608: Scientific Literacy - Integration von Naturwissenschaften in die Gesellschaft und Politik** *English title: Scientific Literacy*	4 C 2 SWS
Lernziele/Kompetenzen: **Lernziele**: Dieses interdisziplinäre Modul soll die Kluft zwischen den Naturwissenschaften und den Geistes- und Gesellschaftswissenschaften überbrücken helfen. Die Studierenden aller Fachrichtungen sollen gemeinsam naturwissenschaftliche Erkenntniswege kennenlernen und sie anhand aktueller Themen (z.B. anthropogener Klimawandel) nachvollziehen. Hierzu werden auch Grundlagen der Wissenschaftstheorie vermittelt. **Kompetenzen**: Nach erfolgreichem Absolvieren des Moduls sollten Studierende ein Verständnis für Scientific Literacy (u.a. wissenschaftliche Nachprüfbarkeit, Unterscheidung zwischen naturwissenschaftlichen, politischen und gesellschaftlichen Komponenten einer Bewertung) entwickelt sowie Vermittlungskompetenz erworben haben.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Seminar	
Prüfung: Portfolio (max. 10 Seiten) **Prüfungsvorleistungen:** Vortrag (ca. 30 Minuten) oder äquivalente Leistung sowie aktive Teilnahme **Prüfungsanforderungen:** Grundlagen der Wissenschaftstheorie; Unterscheidung zwischen naturwissenschaftlichen, politischen und gesellschaftlichen Komponenten einer Bewertung.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1 - 4
Maximale Studierendenzahl: 24	

Georg-August-Universität Göttingen **Module B.Phy.8001: Lecture Series in Physics for Data Scientists**	8 C 6 WLH

Learning outcome, core skills: Practical aspects of data acquisition and analysis in different specializations in physics (for example: astrophysics, biophysics, solid-state physics, statistical physics, and/or particle physics) A short introduction to the motivation of various measurements and simulation techniques should be provided.	**Workload:** Attendance time: 84 h Self-study time: 156 h

Course: Lecture Series in Physics for Data Scientists	
Examination: Oral examination (approx. 30 minutes) or written report (max. 15 S.) **Examination prerequisites:** At least 50% of the homework/exercises must be solved successfully **Examination requirements:** Understanding of concepts and various examples given in the lecture series. One should be able to explain the physical context of data acquisition, simulation, and analysis.	8 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Stanley Lai
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.SK-Phy.9001: Papers, Proposals, Presentations: Skills of Scientific Communication**	4 C 2 WLH
Learning outcome, core skills: Goals: Handling of different presentation media (written and oral); presenting complex facts to experts and laymen; skills of communication and scientific discussion	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Papers, Proposals, Presentations: Skills of Scientific Communication (Seminar)	2 WLH
Examination: Lecture (approx. 30 minutes) **Examination prerequisites:** Active participation **Examination requirements:** Independent preparation and scientific publications and their presentation Time for preparation 4 weeks	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Ansgar Reiners
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 18	

Additional notes and regulations: Einbringbar in den Wahlbereich nicht-physikalisch.

Georg-August-Universität Göttingen **Modul M.Che.1314: Biophysikalische Chemie** *English title: Biophysical Chemistry*	6 C 5 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Abschluss des Moduls ... • sollen die Studierenden in der Lage sein, die wesentlichen physikochemischen Zusammenhänge biologischer Materie zu verstehen • die generellen Triebkräfte biologischer Reaktionen kennen • Spektroskopische Methoden zur Strukturbestimmung biologischer Makromoleküle verstehen und anwenden können • die Grundzüge moderner optischer Mikroskopie sowie der Sondenmikroskopie verstanden haben • die Mechanik und Dynamik biologischer Systeme ausgehend vom Einzelmolekül bis zur einzelnen Zelle erörtern können	**Arbeitsaufwand:** Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden
Lehrveranstaltung: Biophysikalische Chemie (Vorlesung)	3 SWS
Prüfung: Klausur (180 Minuten)	6 C
Lehrveranstaltung: Biophysikalische Chemie (Übung)	2 SWS
Prüfungsanforderungen: • Übertragung genereller physikochemischer Prinzipien, wie zum Beispiel der Reaktionsdynamik, (statistischen) Thermodynamik und Quantentheorie auf die Beschreibung biologischer Phänomene • Beschreibung biologisch relevanter Wechselwirkungskräfte, stochastischer Prozesse wie Diffusion, physikalischer Biopolymer-Modelle, der Eigenschaften von Biomembranen und der Visikoelastizität von weicher Materie. • Kenntnisse der wesentlichen Methoden, wie z.B. UV-Vis, Circulardichroismus, Rasterkraftmikroskopie, optische Fallen, Fluoreszenz, und optische Mikroskopie.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Janshoff
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 1 - 2
Maximale Studierendenzahl: 64	

Fakultät für Physik:

Nach Beschlüssen des Fakultätsrats der Fakultät für Physik vom 08.11.2023 und 06.12.2023 hat das Präsidium der Georg-August-Universität Göttingen am 07.02.2024 die Neufassung des Modulverzeichnisses zur Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang „Physics“ genehmigt (§ 44 Abs. 1 Satz 2 NHG, §§ 37 Abs. 1 Satz 3 Nr. 5 b), 44 Abs. 1 Satz 3 NHG).

Die Neufassung des Modulverzeichnisses tritt nach deren Bekanntmachung in den Amtlichen Mitteilungen II zum 01.04.2024 in Kraft.

Georg-August-Universität
Göttingen

Modulverzeichnis

zu der Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang "Physics" (Amtliche Mitteilungen I Nr. 52/2016 S. 1384, zuletzt geändert durch Amtliche Mitteilungen I Nr. 5/2024 S. 45)

Module

Übersicht nach Modulgruppen

I. Master-Studiengang "Physics"

Es müssen nach Maßgabe der folgenden Bestimmungen wenigstens 120 C erworben werden.

1. Praktika

Es müssen folgende Praktika im Umfang von insgesamt 12 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

a. Praktikum Teil I

Es muss eines der beiden folgenden Module im Umfang von 6 C erfolgreich absolviert werden:

b. Praktikum Teil II

Es muss eines der folgenden Wahlpflichtmodule im Umfang von 6 C erfolgreich absolviert werden; das Modul B.Phy.606 darf nur gewählt werden, sofern es nicht bereits im Bachelorstudium eingebracht wurde:

2. Forschungsschwerpunkt

Der Master-Studiengang "Physics" muss mit einem der fünf Studienschwerpunkte "Astro- und Geophysik", "Biophysik und Physik komplexer Systeme", "Festkörper- und Materialphysik", "Kern- und Teilchenphysik" oder "Theoretische Physik" im Umfang von jeweils wenigstens 56 C nach Maßgabe der folgenden Bestimmungen studiert werden.

a. Forschungsschwerpunkt "Astro- und Geophysik"

Es müssen Module im Umfang von insgesamt wenigstens 56 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

aa. Erster Studienschnitt (1. und 2. Semester)

Es müssen Module im Umfang von insgesamt wenigstens 26 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Forschungsseminar

Es muss folgendes Modul im Umfang von 4 C erfolgreich absolviert werden:

ii. Wahlpflichtbereich A

Es muss folgendes Modul im Umfang von 8 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Sind alle hier genannten Module bereits im Bachelor im Rahmen der 180 C eingebracht worden, sind alle 26 C aus iii zu wählen.

iii. Wahlpflichtbereich B

Ergänzend muss die Differenz zu den 26 C durch erfolgreiche Absolvierung wenigstens zwei der folgenden Module erbracht werden; bereits im Bachelorstudium absolvierte Module können nicht berücksichtigt werden:

bb. Zweiter Studienabschnitt (3. Semester)

Es müssen folgende drei Module im Umfang von insgesamt 30 C erfolgreich absolviert werden:

b. Forschungsschwerpunkt "Biophysik und Physik komplexer Systeme"

Es müssen Module im Umfang von insgesamt wenigstens 56 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

aa. Erster Studienabschnitt (1. und 2. Semester)

Es müssen Module im Umfang von insgesamt wenigstens 26 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Forschungsseminar

Es muss folgendes Modul im Umfang von 4 C erfolgreich absolviert werden:

ii. Wahlpflichtbereich A

Es muss mindestens eines der folgenden Module im Umfang von 6 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Sind alle hier genannten Module bereits im Bachelor im Rahmen der 180 C eingebracht worden, sind alle 26 C aus iii zu wählen.

iii. Wahlpflichtbereich B

Ergänzend muss die Differenz zu den 26 C durch erfolgreiche Absolvierung wenigstens zwei der folgenden Module erbracht werden; bereits im Bachelorstudium absolvierte Module können nicht berücksichtigt werden:

Es müssen folgende drei Module im Umfang von insgesamt 30 C erfolgreich absolviert werden:

c. Forschungsschwerpunkt "Festkörper- und Materialphysik"

Es müssen Module im Umfang von insgesamt wenigstens 56 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

aa. Erster Studienabschnitt (1. und 2. Semester)

Es müssen Module im Umfang von insgesamt wenigstens 26 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Forschungsseminar

Es muss folgendes Modul im Umfang von 4 C erfolgreich absolviert werden:

ii. Wahlpflichtbereich A

Es muss mindestens eines der folgenden Module im Umfang von wenigstens 4 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Sind alle hier genannten Module bereits im Bachelor im Rahmen der 180 C eingebracht worden, sind alle 26 C aus iii zu wählen.

iii. Wahlpflichtbereich B

Ergänzend muss die Differenz zu den 26 C durch erfolgreiche Absolvierung wenigstens eines der folgenden Module erbracht werden; bereits im Bachelorstudium absolvierte Module können nicht berücksichtigt werden:

bb. Zweiter Studienabschnitt (3. Semester)

Es müssen folgende drei Module im Umfang von insgesamt 30 C erfolgreich absolviert werden:

d. Forschungsschwerpunkt "Kern- und Teilchenphysik"

Es müssen Module im Umfang von insgesamt wenigstens 56 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

aa. Erster Studienabschnitt (1. und 2. Semester)

Es müssen Module im Umfang von insgesamt wenigstens 26 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Forschungsseminar

Es muss folgendes Modul im Umfang von 4 C erfolgreich absolviert werden:

ii. Wahlpflichtbereich A

Es muss das folgende Modul im Umfang von 8 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Wurde das folgende Modul bereits im Bachelor im Rahmen der 180 C eingebracht worden, sind weitere 8 C aus iii und iv zu wählen.

iii. Wahlpflichtbereich B

Es muss mindestens eines der folgenden Module im Umfang von 6 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Wurden alle zwei folgenden Module bereits im Bachelor im Rahmen der 180 C eingebracht worden, sind weitere 6 C aus iv zu wählen. Die Bestimmungen zu ii bleiben hiervon unberührt.

iv. Wahlpflichtbereich C

Ergänzend muss die Differenz zu den 26 C durch erfolgreiche Absolvierung wenigstens eines der folgenden Module erbracht werden; bereits im Bachelorstudium absolvierte Module können nicht berücksichtigt werden:

bb. Zweiter Studienabschnitt (3. Semester)

Es müssen folgende drei Module im Umfang von insgesamt 30 C erfolgreich absolviert werden:

e. Forschungsschwerpunkt "Theoretische Physik"

Es müssen Module im Umfang von insgesamt wenigstens 56 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

aa. Erster Studienabschnitt (1. und 2. Semester)

Es müssen Module im Umfang von insgesamt wenigstens 26 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Forschungsseminar

Es muss folgendes Modul im Umfang von 4 C erfolgreich absolviert werden:

ii. Wahlpflichtbereich A

Es müssen folgende beiden Module im Umfang von 12 C erfolgreich absolviert und ins Zeugnis eingebracht werden. Bereits im Bachelor eingebrachte Module können nicht berücksichtigt werden. Wurden diese Module bereits im Bachelor im Rahmen der 180 C eingebracht, sind weitere Module im Umfang der bereits im Bachelor eingebrachten Credits nach den Bestimmungen des nachfolgenden Punktes iii zu wählen.

iii. Wahlpflichtbereich B

Die Differenz zu mindestens 20 C bis maximal 26 C muss durch erfolgreiche Absolvierung einer Auswahl aus den folgenden Modulen erbracht werden:

iv. Wahlpflichtbereich C

Werden weniger als 26 C aus Buchstabe i-iii erbracht kann die Differeznz durch erfolgreiche Absolvierung wenigstens eines der folgenden Module oder der unter Buchstabe a/aa/iii aufgeführten Module mit Modulnummern der Formate M.Phy.54X, M.Phy.54XX bzw. B.Phy.54XX, der unter Buchstabe b/aa/iii aufgeführten Module mit Modulnummern der Formate M.Phy.56X, M.Phy.56XX bzw. B.Phy.56XX, der unter Buchstabe c/aa/ii+iii aufgeführten Module mit Modulnummern der Formate M.Phy.57X, M.Phy.57XX bzw. B.Phy.57XX oder der unter Buchstabe d/aa/iii+iv aufgeführten Module mit Modulnummern der Formate M.Phy.58X, M.Phy.58XX bzw. B.Phy.58XX im Umfang von insgesamt wenigstens 6 C erbracht werden; bereits im Bachelorstudium absolvierte Module können nicht berücksichtigt werden:

bb. Zweiter Studienabschnitt (3. Semester)

Es müssen folgende drei Module im Umfang von insgesamt 30 C erfolgreich absolviert werden:

3. Profilierungsbereich

Es müssen Module im Umfang von insgesamt wenigstens 22 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

a. Profilierungsseminar

Es muss folgendes Pflichtmodul im Umfang von 4 C erfolgreich absolviert werden:

b. Profilierungsbereich Mathematik-Naturwissenschaften

Es müssen aus dem Lehrangebot der mathematisch-naturwissenschaftlichen Fakultäten (inkl. Fakultät für Physik) Module im Umfang von insgesamt wenigstens 6 C erfolgreich absolviert werden. Wählbar sind insbesondere nach Nr. 2 nicht eingebrachte Module sowie die nachfolgenden Module; darüber hinaus wird ein Verzeichnis wählbarer Module durch die Fakultät für Physik in geeigneter Weise bekannt gemacht. Bachelormodule können nur eingebracht werden, sofern sie nicht bereits im Rahmen des Bachelorstudiums erfolgreich absolviert wurden.

c. Schlüsselkompetenzen

Es müssen Module im Umfang von insgesamt wenigstens 12 C aus dem Lehrangebot der Universität außerhalb der Fakultät für Physik erfolgreich absolviert werden. Wählbar sind Angebote aufgrund der Prüfungsordnung für Studienangebote der Zentralen Einrichtung für Sprachen und Schlüsselqualifikationen (ZESS); darüber hinaus wird ein Verzeichnis wählbarer Module durch die Fakultät für Physik in geeigneter Weise bekannt gemacht.

d. Alternativmodule

Anstelle der Module nach Buchstaben a und b können auf Antrag, der an die Studiendekanin oder den Studiendekan der Fakultät für Physik zu richten ist, andere Module (Alternativmodule) nach Maßgabe der nachfolgenden Bestimmungen absolviert werden. Dem Antrag ist die Zustimmung der Studiendekanin oder des Studiendekans der Fakultät oder Lehreinheit, die das Alternativmodul anbietet, beizufügen. Die Entscheidung trifft die Studiendekanin oder der Studiendekan der Fakultät für Physik. Der Antrag kann ohne Angabe von Gründen abgelehnt werden; ein Rechtsanspruch der Antragstellerin oder des Antragstellers auf Zulassung eines Alternativmoduls besteht nicht.

4. Masterarbeit

Durch die erfolgreiche Anfertigung der Masterarbeit werden 30 C erworben.

II. Ergänzende Hinweise zu Modulprüfungen

Soweit in diesem Modulverzeichnis Modulbeschreibungen in englischer Sprache veröffentlicht werden, gilt für die verwendeten Prüfungsformen nachfolgende Zuordnung:

written exam - Klausur

written/supplementary report/elaboraton - schriftliche/-r Bericht/Ausarbeitung

presentation - Präsentation

term paper - Hausarbeit

oral exam - mündliche Prüfung

handout -Handout

lecture/talk - Vortrag

report - Protokoll

Georg-August-Universität Göttingen **Modul B.Che.2301: Chemische Reaktionskinetik** *English title: Kinetics of Chemical Reactions*	6 C 5 SWS
Lernziele/Kompetenzen: Die Studierenden können chemische Elementarreaktionen, Transportvorgänge und Reaktionsmechanismen in verschiedenen Aggregatzuständen analysieren bzw. auf molekularer Basis verstehen. Sie sind mit Anwendungen der Reaktionskinetik in Gebieten wie der Photochemie, Atmosphärenchemie und Umweltchemie vertraut.	**Arbeitsaufwand:** Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden
Lehrveranstaltung: Vorlesung: Chemische Reaktionskinetik (Vorlesung)	3 SWS
Lehrveranstaltung: Übung zu: Chemische Reaktionskinetik (Übung)	2 SWS
Prüfung: Klausur (180 Minuten)	6 C
Prüfungsanforderungen: Formale Reaktionskinetik, experimentelle Methoden der Reaktionskinetik, theoretische Beschreibung von Elementarreaktionen und Transportvorgängen, Anwendungen der Reaktionskinetik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Alec Wodtke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Che.4104: Allgemeine und Anorganische Chemie (Lehramt und Nebenfach)** *English title: Introduction to General and Inorganic Chemistry*	6 C 6 SWS
Lernziele/Kompetenzen: Die Studierenden verstehen die allgemeinen Prinzipien und Gesetzmäßigkeiten der Chemie und sind mit grundlegenden Begriffen der allgemeinen und anorganischen Chemie vertraut. Sie erwerben erste Kenntnisse der anorganischen Stoffchemie.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: "Experimentalchemie I (Allgemeine und Anorganische Chemie)" (Vorlesung)	4 SWS
Lehrveranstaltung: "Experimentalchemie I (Allgemeine und Anorganische Chemie)" (Übung)	2 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** Erfolgreiche Teilnahme an den Übungen; Näheres regelt die Übungs-Ordnung	6 C
Prüfungsanforderungen: Allgemeine Chemie: Atombau und Periodensystem, Elemente und Verbindungen, Chemische Gleichungen und Stöchiometrie, Lösungen und Lösungsvorgänge, chemische Gleichgewichte, einfache Thermodynamik und Kinetik, Säure-Base-Reaktionen, Fällungs- und Komplexbildungsreaktionen, Redoxreaktionen; Grundlagen der Anorganischen Chemie: Vorkommen, Darstellung, Eigenschaften einiger Elemente und ihrer wichtigsten Verbindungen.	

Zugangsvoraussetzungen: Keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Dietmar Stalke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:**

Georg-August-Universität Göttingen **Modul B.Che.9107: Chemisches Praktikum für Studierende der Physik und Geowissenschaften** *English title: Laboratory course in General and Inorganic Chemistry for Physisists and Geologists*	6 C 8 SWS
Lernziele/Kompetenzen: Verstehen der allgemeinen Prinzipien und Gesetzmäßigkeiten der allgemeinen und anorganischen Chemie, sicherer Umgang mit deren Begriffen. Anwendung der im Modul B.Che.4104 erworbenen Kenntnisse der anorganischen Stoffchemie, Kennenlernen experimenteller Arbeitstechniken anhand von Schlüsselreaktionen. Integrative Vermittlung von Schlüsselkompetenzen: Teamarbeit; gute wissenschaftliche Praxis; Protokollführung; sicheres Arbeiten im Labor.	**Arbeitsaufwand:** Präsenzzeit: 112 Stunden Selbststudium: 68 Stunden
Lehrveranstaltung: Chemisches Praktikum für Studierende der Physik und Geowissenschaften *Angebotshäufigkeit:* jedes Semester	6 SWS
Lehrveranstaltung: Seminar zum Chemischen Praktikum für Studierende der Physik und Geowissenschaften (Seminar) *Angebotshäufigkeit:* jedes Semester	2 SWS
Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** Erfolgreiche Teilnahme am Praktikum, Details siehe Praktikumsordnung **Prüfungsanforderungen:** Atombau und Periodensystem, Grundbegriffe, Elemente und Verbindungen, Aufbau der Materie, einfache Bindungskonzepte, Chemische Gleichungen und Stöchiometrie, Chemische Gleichgewichte, einfache Thermodynamik und Kinetik, Säure-Base-Reaktionen inklusive Puffer, Redoxreaktionen, Löslichkeit, einfache Elektrochemie, Vorkommen, Darstellung und Eigenschaften der Elemente und ihrer wichtigsten Verbindungen, Einführung in spektroskopische Methoden.	6 C

Zugangsvoraussetzungen: B.Che.4104	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Franc Reimer Meyer
Angebotshäufigkeit: jedes Wintersemester (Blockpraktikum in vorlesungsfreier Zeit) und jedes Sommersemester (in der Vorlesungszeit)	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:**

Bemerkungen:
Das Seminar wird von den Dozierenden und Assistent/innen der Anorganischen Chemie durchgeführt.

Ansprechpersonen für das Praktikum sind Frau Dr. Stückl sowie die entsprechenden Assistent/innen.

Georg-August-Universität Göttingen **Modul B.Inf.1101: Grundlagen der Informatik und Programmierung** *English title: Introduction to Computer Science and Programming*	10 C 6 SWS
Lernziele/Kompetenzen: Studierende • kennen grundlegende Begriffe, Prinzipien und Herangehensweisen der Informatik, kennen einige Programmierparadigmen und Grundzüge der Objektorientierung. • erlangen elementare Grundkenntnisse der Aussagenlogik, verstehen die Bedeutung für Programmsteuerung und Informationsdarstellung und können sie in einfachen Situationen anwenden. • verstehen wesentliche Funktionsprinzipien von Computern und der Informationsdarstellung und deren Konsequenzen für die Programmierung. • erlernen die Grundlagen einer Programmiersprache und können einfache Algorithmen in dieser Sprache codieren. • kennen einfache Datenstrukturen und ihre Eignung in typischen Anwendungssituationen, können diese programmtechnisch implementieren. • analysieren die Korrektheit einfacher Algorithmen und bewerten einfache Algorithmen und Probleme nach ihrem Ressourcenbedarf.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 216 Stunden
Lehrveranstaltung: Informatik I (Vorlesung, Übung)	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Nachweis von 50% der in den Übungsaufgaben erreichbaren Punkte. Kontinuierliche Teilnahme an den Übungen. **Prüfungsanforderungen:** In der Prüfung wird das Verständnis der vermittelten Grundbegriffe sowie die aktive Beherrschung der vermittelten Inhalte und Techniken nachgewiesen, z.B. • Kenntnis von Grundbegriffen nachweisen durch Umschreibung in eigenen Worten. • Standards der Informationsdarstellung in konkreter Situation umsetzen. • Ausdrücke auswerten oder Bedingungen als logische Ausdrücke formulieren usw. • Programmablauf auf gegebenen Daten geeignet darstellen. • Programmcode auch in nicht offensichtlichen Situationen verstehen. • Fehler im Programmcode erkennen/korrigieren/klassifizieren. • Datenstrukturen für einfache Anwendungssituationen auswählen bzw. geeignet in einem Kontext verwenden. • Algorithmen für einfache Probleme auswählen und beschreiben (ggf. nach Hinweisen) und/oder einen vorgegebenen Algorithmus (ggf. fragmentarisch) programmieren bzw. ergänzen. • einfache Algorithmen/Programme nach Ressourcenbedarf analysieren. • einfachsten Programmcode auf Korrektheit analysieren. • einfache Anwendungssituation geeignet durch Modul- oder Klassenschnittstellen modellieren. Die Klausur wird als **E-Prüfung** durchgeführt.	10 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Carsten Damm
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** ab bis
Maximale Studierendenzahl: 300	

Georg-August-Universität Göttingen **Modul B.Inf.1102: Grundlagen der Praktischen Informatik** *English title: Introduction to Computer Systems*	10 C 6 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Die Studierenden • beherrschen die Grundlagen einer deklarativen Programmiersprache und können Programme erstellen, testen und analysieren. • beherschen die Grundlagen einer Programmiersprache, die als Skriptsprache nutzbar ist, und können Skripte erstellen, testen und analysieren. • kennen Aufgaben und Struktur eines Betriebssystems, die Verfahren zur Verwaltung, Scheduling und Synchronisation von Prozessen und zur Speicherverwaltung, sie können diese Verfahren jeweils anwenden, analysieren und vergleichen. • kennen Grundlagen und verschiedene Beschreibungen von formalen Sprachen, z.B. Automaten und Grammatiken, und können diese konstruieren, analysieren und vergleichen. • kennen Grundlagen des Compilerbaus und können einfache Versionen der zugehörigen Softwarewerkzeuge, z.B. Lexer, Parser, Interpeter und Compiler, konstruieren und analysieren. • kennen verschiedene Teilgebieten der formalen Logik, z.B. Aussagen- und Prädikatenlogik, und darauf beruhende Verfahren, z.B. Auswertung, Konstruktion und Resolution, und können diese anwenden. • kennen die Schichtenarchitektur von Computernetzwerken, sowie sowohl Dienste als auch Protokolle und können diese analysieren und vergleichen. • kennen unterschiedliche Verschlüsselungsverfahren, z.B. symmetrische und asymmetrische, sowie Methoden sowohl zum Schlüsselaustausch als auch zur Schlüsselvereinbarung und können diese anwenden, analysieren und vergleichen. • kennen die Grundlagen einzelnen Teilgebiete der Softwaretechnik, z.B. Softwaretest, und können diese anwenden und analysieren.	Präsenzzeit: 84 Stunden Selbststudium: 216 Stunden

Lehrveranstaltung: Grundlagen der Praktischen Informatik (Vorlesung, Übung)	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Nachweis von 50% der in den Übungsaufgaben erreichbaren Punkte. Kontinuierliche Teilnahme an den Übungen. **Prüfungsanforderungen:** Deklarative Programmierung, Programmierung von Skripten, Betriebssysteme, formale Sprachen, Compilerbau, formale Logik, Telematik, Kryptographie, Softwaretechnik Die Klausur wird als **E-Prüfung** durchgeführt.	10 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Inf.1101
Sprache:	**Modulverantwortliche[r]:**

Deutsch	Dr. Henrik Brosenne
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 300	

Georg-August-Universität Göttingen **Modul B.Phy.1511: Einführung in die Kern- und Teilchenphysik** *English title: Introduction to Particle Physics*	8 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls kennen die Studierenden physikalische Fakten und Modellvorstellungen über den Aufbau der Atomkerne und die Eigenschaften von Elementarteilchen. Außerdem sollten sie mit den grundlegenden Begriffen und Modellen der Kern- und Teilchenphysik umgehen können.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 156 Stunden
Lehrveranstaltung: Einführung in die Kern- und Teilchenphysik	
Prüfung: Klausur (120 Min.) oder mdl. Prüfung (ca. 30 Min.) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein.	8 C
Prüfungsanforderungen: Eigenschaften und Spektroskopie von stabilen und instabilen Atomkernen; Eigenschaften von Elementarteilchen und Experimente der Hochenergiephysik; Grundlagen der Teilchenbeschleunigerphysik.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 180	

Georg-August-Universität Göttingen **Module B.Phy.1512: Particle physics II - of and with quarks**	6 C 6 WLH

Learning outcome, core skills: After successful completion of this module, students should be familiar with the properties and interactions of quarks as well as with experimental methods and experiments which lead to their discovery and are used for precise studies.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Particle physics II - of and with quarks (Lecture)	4 WLH
Course: Particle physics II - of and with quarks (Exercise)	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Concepts and methods along with specific implementations of statistical methods in data analysis. Properties and discovery of quarks, discovery of W and Z bosons at hadron colliders, the top-quark, CKM mixing matrix, decays of heavy quarks, quark mixing and oscillations, CP-violation, jets, gluons and fragmentation, deep-inelastic scattering, QCD tests and measurement of the strong coupling alpha_s.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.1521: Einführung in die Festkörperphysik** *English title: Introduction to Solid State Physics*	8 C 6 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls haben die Studierenden die Grundlagen und die physikalische Erscheinungen der Zusammenhalt der Ionen und Elektronen in einem Festkörper mit idealen periodischen Anordnung der konstituierenden Atomen verinnerlicht. Basierend auf der Eigenschaften freier Atomen und deren Wechselwirkung im Kristallgitter wird ein grundlegendes Verständnis verschiedener kollektiven Phänomene gewonnen. Dazu gehören beispielsweise die elektronische Bandstruktur im periodischen Gitterpotential (Dynamik der Elektronen) sowie die Gitterschwingungen (Dynamik der Ionen), die Elektrizitätsleitung - auch in niederdimensionalen Strukturen - sowie thermische Eigenschaften (spezifische Wärme).	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 156 Stunden
Lehrveranstaltung: Vorlesung und Übung Einführung in die Festkörperphysik	
Prüfung: Klausur (120 min.) oder mdl. Prüfung (ca. 30 min.) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Grundlagen, Phänomene und Modelle für Elektronen- und Gitterdynamik in Festkörpern. Insbesondere, Chemische Bindung in Festkörpern, Atomare Kristallstruktur, Streuung an periodischen Strukturen, das Elektronengas ohne Wechselwirkung (Freie Elektronen), das Elektronengas mit Wechselwirkung (Abschirmung, Plasmonen), das periodische Potential (Bandstrukturd der Kristall-Elektronen), Gitterschwingungen (Phononen) und spezifische Wärme	8 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Angela Rizzi
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 120	

Georg-August-Universität Göttingen Module B.Phy.1522: Solid State Physics II	6 C 4 WLH
Learning outcome, core skills: After successful completion of this Module students will be able to understand: • The role of the band-structure for electron and lattice dynamics • The motion of crystal electrons/holes in electric and magnetic fields • Quasiparticle scattering processes • The deviation of macroscopic dielectric properties from microscopic theory • The dielectric properties of metals and plasma oscillations • Independent electron magnetism and the emergence of collective magnetic phenomena • Magnetic ordering phenomena • The BCS theory of superconductivity	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Solid State Physics II	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Examination topics: Basics, phenomena and models for electrons and lattice dynamics in solids. Concepts of quasi-particle interaction: Transport phenomena incl. electrical and thermal conductivity, dielectric properties, plasmons. Semiconductors, magnetic properties of solids, superconductivity.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics
Language: German, English	**Person responsible for module:** Prof. Dr. Stefan Dirk Mathias
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 120	

Georg-August-Universität Göttingen **Module B.Phy.1531: Introduction to Materials Physics**	4 C 4 WLH

Learning outcome, core skills: This 2 week long intensive course is offered between the winter and summer semesters. It applies the knowledge obtained in the Einführung in die Festkörperphysik and Thermodynamik und statistische Physik to understanding the structure, properties and dynamic behavior of the materials we use in our everyday lives. **Learning outcomes:** crystal defects, disordered systems, impurities, crystalline mixtures and alloys, phase diagrams, phase transformations, diffusion, kinetics, materials selection, structure-property relations. **Core skills:** The students will gain an understanding of the different materials classes that we use in everyday life, including: how properties of materials are determined by their atomic scale structure, which driving forces determine the structure of equilibrium phases, and how kinetic processes control phase transformations and the dynamics of non-equilibrium processes.	**Workload:** Attendance time: 56 h Self-study time: 64 h

Course: Introduction to Materials Physics (Lecture)	2 WLH
Examination: Written or oral examWritten exam (120 minutes) or oral examination (approximately 30 minutes) **Examination prerequisites:** 50% of the homework problems must be solved successfully. **Examination requirements:** Crystal defects, disordered systems, impurities, crystalline mixtures and alloys, phase diagrams, phase transformations, diffusion, kinetics, materials selection.	4 C

Course: Introduction to Materials Physics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** • Experimentelle Methoden der Materialphysik, • Einführung in die Festkörperphysik, • Thermodynamik und statistische Physik
Language: English	**Person responsible for module:** Prof.in Cynthia Ann Volkert
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.1541: Einführung in die Geophysik** *English title: Introduction to Geophysics*	4 C 3 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls können die Studierenden mit den grundlegenden Begriffen und Modellen der Geophysik umgehen: • Treibhauseffekt • Gravimetrie • Seismologie • Elektromagnetische Tiefenforschung • Altersbestimmung • Gezeiten • Konvektion • Erdmagnetfeld • Fraktale und chaotische Prozesse • Plattentektonik	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 78 Stunden
Lehrveranstaltung: Vorlesung und Übung zu Einführung in die Geophysik	
Prüfung: Klausur (120 min.) oder mdl. Prüfung (ca. 30 min.) **Prüfungsvorleistungen:** Mindestens 50% der Hausaufgaben in den Übungen müssen bestanden worden sein. **Prüfungsanforderungen:** Grundlagen der Geophysik, insbes. Plattentektonik, Erdbeben	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Tilgner
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 2
Maximale Studierendenzahl: 120	

Georg-August-Universität Göttingen **Module B.Phy.1551: Introduction to Astrophysics**	8 C 6 WLH

Learning outcome, core skills: After successful completion of the module students are familiar with the basic concepts of astrophysics in observation and theory. In particular, they • have gained an overview of observational techniques in astronomy • understand the basic physics of the formation, structure and evolution of stars and planets have learned about the classification and structure of normal and active galaxies • understand the basic physics of homogeneous cosmology and cosmological structure formation	**Workload:** Attendance time: 84 h Self-study time: 156 h

Course: Lecture and exercises for introduction to astrophysics	
Examination: oral (approx. 30 minutes) or written (120 min.) exam **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully. **Examination requirements:** Observational techniques, Planets and exoplanets, planet formation, stellar formation, structure and evolution, galaxies, AGN and quasars, cosmology, structure formation	8 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Jens Carsten Niemeyer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1
Maximum number of students: 120	

Georg-August-Universität Göttingen **Module B.Phy.1561: Introduction to Physics of Complex Systems**	6 C 6 WLH
Learning outcome, core skills: Sound knowledge of essential methods and concepts from Nonlinear Dynamics and Complex Systems Theory, including practical skills for analysis and simulation (using, for example, the programming language python) of dynamical systems.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Introduction to Physics of Complex Systems (Lecture)	4 WLH
Examination: written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully. **Examination requirements:** • Knowledge of fundamental principles and methods of Nonlinear Physics • Modern experimental techniques and theoretical models of Complex Systems theory.	6 C
Course: Introduction to Physics of Complex Systems (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic programming skills (for the exercises)
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp Prof. Dr. Ulrich Parlitz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 2
Maximum number of students: 120	

Georg-August-Universität Göttingen **Module B.Phy.1571: Introduction to Biophysics**	6 C 6 WLH
Learning outcome, core skills: After attending this course, students will have basic knowledge about • the build-up of cells and the function of the components • transport phenomena on small length scales, derivation and solution of the diffusion equation • laminar hydrodynamics and its application in biological systems (flow, swimming, motility) • reaction kinetics and cooperativity, including enzymes • non-covalent interaction forces • self-assembly • biological (lipid) membrane build-up and dynamics • biopolymer physics and cytoskeletal filaments, including filament and cell mechanics • neurobiophysics • experimental methods, including state-of-the-art microscopy	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Introduction to Biophysics (Lecture) *Contents*: components of the cell; diffusion, Brownian motion and random walks; low Reynolds number hydrodynamics; chemical reactions, cooperativity and enzymes; biomolecular interaction forces and self-assembly; membranes; polymer physics and mechanics of the cytoskeleton; neurobiophysics; experimental methods and microscopy	4 WLH
Examination: Written exam (120 min.) or oral exam (ca. 30 min.) **Examination prerequisites:** At least 50% of the homework problems have to be solved successfully. **Examination requirements:** Knowledge of the fundamental principles, theoretical descriptions and experimental methods of biophysics.	6 C
Course: Introduction to Biophysics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 2
Maximum number of students: 100	

Georg-August-Universität Göttingen **Modul B.Phy.1603: Vermittlung wissenschaftlicher Zusammenhänge durch neue Medien** *English title: Procurement of scientific phenomena via new media*	4 C 2 SWS

Lernziele/Kompetenzen: In dieser Veranstaltung werden Grundkonzepte und Regeln des Videofilmens physikalischer/naturwissenschaftlicher Phänomene vermittelt, treatments erstellt, und das Drehen von Filmen handwerklich geübt. Physikalische Phänomene z.B. aus der Physik-Show "Zauberhafte Physik" werden gefilmt und in Kombination mit Archivmaterial zu kurzen Video-Clips zusammengeschnitten. Dabei wird unter anderem ein Schwerpunkt auf die allgemeinverständliche physikalische Erklärung (Pädagogik) gelegt. Es wurden aber auch formale Aspekte im Umgang mit Medien wie Copyrights, GEMA-Gebühren, Rechte am eigenen Bild etc. vermittelt. Die Video-Clips werden nach Abnahme durch die Seminarleitung und die Presseabteilung in den offiziellen Youtube-Kanal der Georg-August-Universität Göttingen gestellt. Beispiele aus vergangenen Semester sind unter „Zauberhafte Physik“ auf http://www.youtube.de zu finden.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Seminar (Seminar)	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** Aktive Teilnahme **Prüfungsanforderungen:** Physikalische/wissenschaftliche Zusammenhänge allgemeinverständlich und unterstützt durch den Einsatz von selbstgedrehten Videofilmen erklären zu können.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Arnulf Quadt
Angebotshäufigkeit: jedes Wintersemester1	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 5 - 6; Master: 1 - 4
Maximale Studierendenzahl: 16	

Georg-August-Universität Göttingen **Modul B.Phy.1609: Grundlagen zur Einheit von Mensch und Natur** *English title: Foundations of the Unity of Human and Nature*	4 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten Studierende Einblicke in die naturwissenschaftlichen, ökonomischen und weltanschaulichen Grundlagen der Wechselbeziehung Mensch – Natur gewonnen haben. Sie sollten... • über Grundlagen in der Systemdynamik komplexer Systeme verfügen; • mit Präsentationsmedien umgehen können; • komplexe Sachverhalte vor Experten und fachfremden Zuhörern präsentieren können; • den Erkenntnisforschritt im Seminar kritisch reflektieren können. Als Schlüsselkompetenzen sollten sie Diskussionsfähigkeit, Kritikfähigkeit und Ausdrucksfähigkeit erworben haben.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Grundlagen zur Einheit von Mensch und Natur	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** Aktive Mitwirkung an der Diskussion der Präsentationen und Erarbeitung eines laufenden Erkenntnisfortschritt des Seminars als Hausaufgabe **Prüfungsanforderungen:** Verständnis der wissenschaftlichen Grundlagen der Wechselbeziehung Mensch-Natur anhand wissenschaftlicher Fachliteratur. Die Entwicklung des Stoffwechsels des Menschen mit der Natur, insbesondere in der Produktion und Reproduktion von Gütern behandelt und ihre philosophische Reflektion wird behandelt. Der Schwerpunkt liegt auf der modernen Entwicklung der internationalen kapitalistischen Produktion zu einem dominanten Einflussfaktor auf die Biosphäre, die daraus resultierenden Möglichkeiten und die Faktoren der möglichen Untergrabung der Einheit von Mensch und Natur in einer globalen Umweltkatastrophe.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul B.Phy.5001: Die Vermittlung und Untersuchung von strömungsphysikalischen Vorgängen im Experiment Teil I** *English title: Teaching and analysis of flow dynamic processes in physical experiments Part I*	6 C 4 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • die strömungsphysikalischen Grundlagen beherrschen und Messverfahren zur Strömungsvisualisierung an Beispielen anwenden können; • die Strömungsphysikalischen Phänomene anhand von Experimenten vorstellen und erklären können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Vorlesung (Vorlesung)	2 SWS
Prüfung: 80 % mündliche Prüfung (ca. 30 Min.) + 20 % Praktische Prüfung (Experiment) (ca. 30 Min.)	6 C

Lehrveranstaltung: Übung	2 SWS

Prüfungsanforderungen: Auftrieb; Bernoulli-Gleichung; Energiebetrachtung von Strömungsvorgängen; Wirbelablösung; Kontinuitätsgleichung; Wirbelbildung/Entstehung in Abhängigkeit von der Reynoldszahl; Messverfahren zur Visualisierung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. nat. Oliver Boguhn
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Phy.5002: Die Vermittlung und Untersuchung von strömungsphysikalischen Vorgängen im Experiment Teil II** *English title: Teaching and analysis of flow dynamic processes in physical experiments Part II*	6 C 4 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • die theoretischen Grundlagen praxisbezogen anwenden und strömungsphysikalische Gesetzmäßigkeiten in Experimenten verifizieren können; • die strömungsphysikalischen Phänomene anhand von Experimenten vorstellen und erklären können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vorlesung (Vorlesung)	2 SWS
Prüfung: mündliche Prüfung (ca. 30 Min.) + Praktische Prüfung (Experiment) (ca. 30 Min.)	6 C
Lehrveranstaltung: Übung	2 SWS
Prüfungsanforderungen: Wirbelbildung/Entstehung in Abhängigkeit von der Reynoldszahl, Schwingungs- und Flatteranalyse, Schallentstehung, Ausbreitung, Quellenund Entfernungsabhängigkeiten, Strömungsvorgänge unter Schwerelosigkeit, Strahlungsinduzierte Strömungsvorgänge, Einfluss der Corioliskraft auf großräumige Strömungen	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. nat. Oliver Boguhn
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Phy.5004: Historische Objekte aus physikalischen Sammlungen** *English title: Historical objects from the physics collections*	4 C 2 SWS
Lernziele/Kompetenzen: Nach der erfolgreichen Teilnahme an der Modulveranstaltung sind die Studierende in der Lage • die physikalischen Grundlagen und Funktion von historischen Instrumenten zu erklären und mit geeigneten Methoden im Team zu präsentieren. • Prozesse der Erkenntnisgewinnung mit historischen Objekten und modernen Instrumenten zu vergleichen und zu bewerten. • Selbständig mit historischen Quellen zu arbeiten. • die Bedeutung historischer Sammlungen zu erkennen. • mit Datenbanken für historische Objekt zu arbeiten und sie als Informationsmedium zu nutzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Physikalische Grundlagen historischer Objekte aus den physikalischen Sammlungen (Seminar)	
Prüfung: Präsentation (ca. 30 Min.) mit schriftlicher Ausarbeitung (Template, max. 10 Seiten) **Prüfungsvorleistungen:** Regelmäßige Teilnahme **Prüfungsanforderungen:** Physikalische Grundlagen des Instruments, Einordnung in den historischen und gesellschaftlichen Kontext, Erkenntnisgewinnung, experimentelle und technische Weiterentwicklung, Klassifizierung des Objekts in einer Datenbank für historische Objekte	4 C
Prüfungsanforderungen: Aufarbeitung und Darstellung eines Gerätes der historischen Sammlung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** apl. Prof. Dr. Susanne Schneider
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 3
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module B.Phy.5402: Advanced Quantum Mechanics**	6 C 6 WLH

Learning outcome, core skills: **Acquisition of knowledge:** After successful completion of the module students will be familiar with the core concepts and mathematical methods of advanced quantum mechanics and quantum many-body theory. **Competencies:** Students will be able to model and analyse single-particle and many-body quantum mechanical systems, drawing also on concepts of quantum information theory.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Advanced Quantum Mechanics (Lecture)	4 WLH
Examination: written exam (120 min.) or oral exam (approx. 30 min.) **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully. **Examination requirements:** Time-dependent perturbation theory, scattering, mixed states, path integrals in quantum mechanics, quantum information, entanglement as resource, many-body systems, second quantisation, basis elements of quantum field theory.	6 C

Course: Advanced Quantum Mechanics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of 1-particle quantum mechanics
Language: English	**Person responsible for module:** Prof. Dr. Stefan Kehrein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 3
Maximum number of students: 80	

Georg-August-Universität Göttingen **Module B.Phy.5403: Fluctuation theorems, stochastic thermodynamics and molecular machines**	3 C 3 WLH

Learning outcome, core skills: After successful completion of the module students will be familiar with the core concepts and mathematical methods of stochastic thermodynamics, the key fluctuation theorems and applications to simple systems. Students will be able to model and analyse strongly fluctuating non-equilibrium processes within the framework of stochastic thermodynamics, in particular in the context of open reaction networks and simple discrete state models of molecular machines.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Fluctuation theorems, stochastic thermodynamics and molecular machines (lecture with exercise if necessary)	
Examination: oral (approx. 30 min.) or written exam (120 min.) **Examination requirements:** Stochastic dynamics (Markov chains), time reversal symmetry, integral and detailed fluctuation theorems, Langevin dynamics, applications to non-equilibrium dynamics of discrete state space models.	3 C

Admission requirements: none	**Recommended previous knowledge:** Module „Statistical mechanics and thermodynamics“ or equivalent knowledge of equilibrium statistical mechanics.
Language: English	**Person responsible for module:** Prof. Dr. Peter Kurt Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 80	

Georg-August-Universität Göttingen **Module B.Phy.5404: Introduction to Statistical Machine Learning**	3 C 3 WLH
Learning outcome, core skills: After successful completion of the module students will be familiar with the core concepts and mathematical methods of statistical machine learning. Students will be able to devise, implement and analyse a range of machine learning approaches based primarily on a Bayesian statistics framework, including methods for regression, classification and approximate inference methods based on connections to statistical physics.	**Workload:** Attendance time: 42 h Self-study time: 48 h
Course: Introduction to Statistical Machine Learning (lecture with exercise if necessary)	
Examination: oral (approx. 30 min.) or written exam (120 min.) **Examination requirements:** Bayesian regression and classification, non-parametric models including Gaussian process, graphical models, variational inference	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic probability theory and linear algebra; familiarity with equilibrium statistical mechanics is helpful
Language: English	**Person responsible for module:** Prof. Dr. Peter Kurt Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 80	

Georg-August-Universität Göttingen Module B.Phy.5405: Active Matter	3 C 2 WLH
Learning outcome, core skills: **Learning objectives**: The students will learn about the basic principles of the physics of active matter as characterized via nonequilibrium statistical physics. Topics will include: physics of micro-swimming, hydrodynamic coordination, continuum description of scalar active matter and motility-induced phase separation, polar active matter and flocking, active liquid crystals (e.g. nematics) and defects, phoretic active matter, activity in enzyme suspensions, and active membranes. **Competences**: This course will give the students a good theoretical understanding of active matter and enable them to follow the state-of-the-art research in the area of active matter.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Active Matter (Lecture)	
Examination: written examination (60 Min.) or oral examination (approx. 30 Min.)	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in statistical physics and hydrodynamics
Language: English	**Person responsible for module:** Prof. Dr. Ramin Golestanian
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5406: Physics with fluctuating paths: stochastic and trajectory thermodynamics**	3 C 3 WLH

Learning outcome, core skills: After successful completion of the module students will be familiar with the core concepts and mathematical methods of stochastic and trajectory thermodynamics including the key fluctuation theorems, statistics of path-based observables and dynamical phase transitions Students will be able to model and analyse strongly fluctuating non-equilibrium processes within the framework of stochastic and trajectory thermodynamics, with applications e.g. in driven systems, non-equilibrium dynamics and reaction networks.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Physics with fluctuating paths: stochastic and trajectory thermodynamics	2 WLH
Course: Physics with fluctuating paths: stochastic and trajectory thermodynamics	1 WLH
Examination: Mdl. Prüfung (ca. 30 Minuten) oder Klausur (120 Minuten) **Examination requirements:** Stochastic dynamics (Markov chains) and Langevin dynamics, entropy production and work, time reversal symmetry and fluctuation theorems, trajectory thermodynamics and large deviations, dynamical phase transitions	3 C

Admission requirements: none	**Recommended previous knowledge:** Module "Statistical mechanics and thermodynamics" or equivalent knowledge of equilibrium statistical mechanics.
Language: German, English	**Person responsible for module:** Prof. Dr. Peter Kurt Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 80	

Georg-August-Universität Göttingen **Modul B.Phy.5501: Aerodynamik** *English title: Aerodynamics*	6 C 4 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sind die Studierenden mit den physikalischen Grundlagen der Aerodynamik vertraut und sollten diese auf elementare aerodynamische Zusammenhänge anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vorlesung Aerodynamik I (Vorlesung)	2 SWS
Lehrveranstaltung: Vorlesung Aerodynamik II (Vorlesung)	2 SWS
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	6 C
Prüfung: Mündlich (ca. 30 Minuten)	6 C
Prüfungsanforderungen: Kontinuumsphysikalische Grundlagen, Grundgleichungen der reibungsfreien und reibungsbehafteteten Strömung, Theorie des Auftriebs, induzierter Widerstand, Kompressibilitäts- und Reibungseffekte und ihre Einordnung über entsprechende Kennzahlen (Machzahl, Reynoldszahl), Grundzüge der Flugmechanik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. rer. nat. Dr. habil. Andreas Dillmann StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 2 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 5 - 6; Master: 1 - 2
Maximale Studierendenzahl: 30	
Bemerkungen: Schwerpunkt: AG, BK	

Georg-August-Universität Göttingen **Modul B.Phy.5502: Aktive Galaxien** *English title: Active galaxies*	3 C 2 SWS
Lernziele/Kompetenzen: Nach dem erfolgreichem Absolvieren des Moduls verfügen die Studierenden Kenntnisse in: • Klassifizierung von Aktiven Galaxien, • spektrale Eigenschaften, • Multifrequenzbeobachtungen, • Struktur und Komponenten der Kernregion, • supermassereiche Schwarze Loecher, • thermische und nichtthermische Strahlungsprozesse, • Energieerzeugung	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Aktive Galaxien (Vorlesung)	
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsanforderungen:** Beherrschen des Stoffs der Vorlesung und der zugehörigen Literatur.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundvorlesung zur Astronomie
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Wolfram Kollatschny
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Phy.5504: Computational Physics** *English title: Computational Physics*	6 C 4 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studenten fortgeschrittene Methoden aus der Computerphysik kennen- und anwenden können, insbesondere Lösen nichtlinearer algebraischer Gleichungssysteme, Diagonalisierung von Matrizen (Eigenwert-Problem), Fast Fourier Transforms sowie Methoden zur Lösung von gewöhnlichen und partiellen Differentialgleichungen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vorlesung + Übung	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Hausarbeit (max. 15 Seiten)	6 C
Prüfung: Klausur (120 Minuten)	6 C
Prüfung: Mündlich Mündliche Prüfung (ca. 30 Minuten)	6 C
Prüfungsanforderungen: Anwendung fortgeschrittener numerischer Verfahren aus der Computerphysik zur Lösung physikalischer Probleme; Beschreiben der Methoden und Auswahl geeigneter Methoden für ein gegebenes Problem.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Programmierkenntnisse, einfache numerische Algorithmen (Programmierkurs, CWR)
Sprache: Deutsch	**Modulverantwortliche[r]:** PD Dr. Wolfram Schmidt Prof. Dominik Schleicher
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1
Maximale Studierendenzahl: 40	

Bemerkungen:
Schwerpunkt alle

Georg-August-Universität Göttingen **Module B.Phy.5505: Data Analysis in Astrophysics**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students are able to model noise and signal.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Vorlesung (Lecture)	
Examination: Oral examination (approx. 30 minutes)	3 C

Examination requirements: Demonstrate an understanding of concepts developed in lecture: Introduction to methods of data analysis in astrophysics: Random signal and noise; correlation analysis; model fitting by least squares and maximum likelihood; Monte Carlo simulations; Fourier analysis; filtering; signal and image processing; Hilbert transform; mapping; applications to problems of astrophysical relevance.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1
Maximum number of students: 40	

Georg-August-Universität Göttingen **Modul B.Phy.5506: Einführung in die Strömungsmechanik** *English title: Introduction to fluid dynamics*	6 C 4 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden Begriffe der Strömungsmechanik auf entsprechende Fragestellungen aus den Bereichen der Geo- und Astrophysik bzw. der Biophysik und der Physik komplexer Systeme anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Vorlesung (Vorlesung)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	6 C
Prüfung: Mündlich (ca. 30 Minuten)	6 C

Prüfungsanforderungen: Theoretische und experimentelle Grundlagen der Strömungsmechanik tropfbarer Flüssigkeiten und Gase: Kontinuumshypothese; Statik, Kinematik und Dynamik von Fluiden; Kontinuitätsgleichung; Bewegungsgleichungen; Dimensionsanalyse; reibungsbehaftete Strömungen, schleichende Strömungen, Grenzschichten, Turbulenz; Potentialströmungen; Wirbelsätze; Impuls- /Impulsmomentengleichungen; Energiegleichung; Stromfadentheorie	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 3
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Phy.5508: Geophysikalische Strömungsmechanik** *English title: Geophysical fluid mechanics*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die Bewegungsformen der flüssigen Bestandteile der Erde (Atmosphäre, Ozeane, Kern) oder anderer Planeten kennen und die Thermodynamik, insbesondere der Atmosphäre, verstehen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung (Vorlesung)	
Prüfung: mündliche Prüfung (ca. 30 Min.) oder Klausur (30 Min.)	
Prüfungsanforderungen: Aufbau der Erdatmosphäre, adiabatischer Gradient und Temperaturschichtung, Corioliskraft und Besonderheiten rotierender Strömungen (geostrophisches Gleichgewicht, Inertial- und Rossbywellen, Ekmanschichten), Strahlungshaushalt, globale Zirkulation der Atmosphäre und Ozeane, Wettersysteme der mittleren Breiten, Schwerewellen, Konvektion, Instabilität und Turbulenz.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Tilgner
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 3
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Schwerpunkt Astro-/Geophysik

Georg-August-Universität Göttingen **Module B.Phy.5511: Magnetohydrodynamics**	3 C 2 WLH
Learning outcome, core skills: After successful comletion of this module, students should be able to apply the fundamental concepts and methods of magnetohydrodynamics to geo- and astrophysical problems.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Lecture (Lecture)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examination (120 minutes)	3 C
Examination: Oral examination (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Andreas Tilgner
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5513: Numerical fluid dynamics**	6 C 4 WLH

Learning outcome, core skills: After completion of this module students should ... • know the basic methods for solving partial differential equations • be able to program and analyze numerical methods for the solution of partial differential equations.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture with exercises	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Term Paper (max. 15 pages)	6 C
Examination: Oral examination (approx. 30 minutes)	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Andreas Tilgner
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5514: Physics of the Interior of the Sun and Stars**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should be able ... • to understand the equations of stellar structure, • to understand current questions about the physics of solar/stellar interiors and magnetism, • to understand the physics of solar/stellar oscillations and their diagnostic potential.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Vorlesung (Lecture)	
Examination: Oral examination (approx. 30 minutes)	3 C

Examination requirements: Demonstrate an understanding of concepts developed in lecture: Introduction to stellar structure, evolution, and dynamics; rotation; convection; dynamos; observations of solar and stellar oscillations; introduction to stellar pulsations; normal modes; weak perturbation theory; numerical forward modeling	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Modul B.Phy.5516: Physik der Galaxien** *English title: Physics of Galaxies*	3 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über Kenntnisse zu folgenden Schwerpunkten: • Klassifizierung von Galaxien, • Helligkeitsprofile, • spektroskopische Eigenschaften, • stellare Population und interstellares Medium, • Kinematik, • Massen(bestimmungsmethoden), • Galaxienentwicklung	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Vorlesung (Vorlesung)	
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsanforderungen:** • morphologische Galaxienklassifikation, • Oberflaechenhelligkeit, • Aufbau und Struktur von Galaxien, • Rotation und Dynamik, • stellare Zusammensetzung und Gaskomponenten des Interstellaren Mediums, • Galaxienmassen, • Skalierungsrelationen, • Galaxienentwicklung	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Wolfram Kollatschny
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Module B.Phy.5517: Physics of the Sun, Heliosphere and Space Weather: Key Knowledge**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the module the participants understand: • the elementary parameters of the Sun-Earth-System, • the origin and different forms of solar activity, • the physical processes of the heliosphere, • the exploration of space and the Sun with space missions, • the effects of the Sun on Earth and space weather.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Physics of the Sun, Heliosphere and Space Weather: Key Knowledge (Lecture) *Contents*: • Basic knowledge of the Sun-Earth-System, • Basic physics of the Sun, its outer atmosphere and its effects on interplanetary spac, • Exploration of the Sun and space with dedicated spacecraft and instruments, • Effects of the Sun on Earth, including cosmic effects, Finally, the research field of space weather, different forecast methods and new projects will be presented.	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examinationWritten examination (120 minutes)	3 C
Examination: Oral examinationoral examination (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Ansgar Reiners Contact Person: Dr. Bothmer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5518: Physics of the Sun, Heliosphere and Space Weather: Space Weather Applications**	3 C 2 WLH
Learning outcome, core skills: Learning outcome: Introduction into the physics processes of space weather based on applied study cases. Core skills: Knowledge about physical processes of space weather and its applications. Ability in self-organised solving of case studies.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Vorlesung (Lecture)	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examination (120 minutes)	3 C
Examination: Oral examination (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Ansgar Reiners Contact person: Dr. Bothmer
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.5521: Seminar zu einem Thema der Geophysik** *English title: Seminar on Geophysics*	4 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten Studierende sich selbstständig in eine Fragestellung aus der Geophysik und Ihrem fachlichen Umfeld einarbeiten und einen Vortrag mit schriftlicher Zusammenfassung erarbeiten können**.**	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden

Lehrveranstaltung: Seminar (Seminar)	
Prüfung: Vortrag (ca. 60 Min.) mit schriftlicher Ausarbeitung (max. 20 S) **Prüfungsvorleistungen:** Aktive Teilnahme	4 C

Prüfungsanforderungen: Selbständige Einarbeitung in ein Thema der Geophysik, Vorbereitung eines für Bachelor-Studenten verständlichen Vortrages mit schriftlicher Zusammenfassung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Tilgner
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 3
Maximale Studierendenzahl: 20	

Bemerkungen: Schwerpunkt Astro-/Geophysik

Georg-August-Universität Göttingen **Module B.Phy.5523: General Relativity**	6 C 6 WLH

Learning outcome, core skills: The students master the foundations of General Relativity mathematically and physically. They are able to perform corresponding computations in simple models.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: General Relativity (Lecture)	4 WLH
Examination: Written examination (120 minutes) **Examination requirements:** Basic structures of Differential geometry, simple examles of computations, Einstein's equation, underlying principles, Schwarzschild space-time, classical tests of General Relativity, foundations of cosmology.	6 C

Course: Excercises	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of Mechanics, Electrodynamics and special Relativity, Analysis of several real variables
Language: German, English	**Person responsible for module:** apl. Prof. Folkert Müller-Hoissen
Course frequency: Two-year as required / Winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 60	

Georg-August-Universität Göttingen Module B.Phy.5531: Origin of solar systems	3 C 2 WLH
Learning outcome, core skills: After finishing the module the students should be able to apply the fundamental knowledge about the structure and the formation of planetary systems to geophysical and astrophysical problems.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Theory and observation of early phases of stars and planetary systems, including extrasolar planets and our own solar system. In particular: Early phases of formation of stars and protoplanetary disks, models of the condensation of molecules and minerals during formation of planetary systems, chemistry and radiation in low-density astrophysical environments, formation of planets and their migration, small solar system bodies as source of information on the early solar system.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Astropyhsics
Language: German, English	**Person responsible for module:** Prof. Dr. Stefan Dreizler Ansprechpartner: Dr. Jockers, Dr. Krüger
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** from 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5538: Stellar Atmospheres**	6 C 4 WLH

Learning outcome, core skills: After successful completion of the modul students should know how to applicate physical concepts (such as atomic and molecular physics, thermodynamics, and statistical physics) in an astrophysical context, and know their implementation in numerical simulations.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Physics of stellar atmospheres (Vorlesung) *Course frequency:* each winter semester	2 WLH
Course: Stellar atmosphere modelling (Computerpraktikum) *Course frequency:* each winter semester	2 WLH
Examination: Oral Exam (ca. 30 Min.)	6 C

Examination requirements: Oral account of the context and concepts learned during the two courses on the topics of interaction of radiation and matter; radiative transfer; structure of stellar atmospheres; and theoretical foundations of spectral analysis; answering of specific questions on all the aspects in this field.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Dreizler
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Additional notes and regulations: Schwerpunkt: Astro-/Geophysik

Georg-August-Universität Göttingen **Module B.Phy.5539: Physics of Stellar Atmospheres**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should understand the interaction of radiation and matter, radiative transfer, structure of stellar atmospheres; thorough understand the theoretical foundations of spectral analysis and know how to applicate physical concepts (such as atomic and molecular physics, thermodynamics, and statistical physics) in an astrophysical context.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Physics of stellar atmospheres (Vorlesung)	
Examination: Oral Exam (ca. 30 Min.)	3 C

Examination requirements: Oral account of the context and concepts of radiative transfer and structure of stellar atmospheres.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Dreizler
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Additional notes and regulations: Schwerpunkt: Astro-/Geophysik

Georg-August-Universität Göttingen **Module B.Phy.5540: Introduction to Cosmology**	3 C 2 WLH
Learning outcome, core skills: After successful completion of the modul students should understand the evolution of the universe on very large scales, knowledge of current questions in physical cosmology.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Lecture Introduction to Cosmology	
Examination: written (120 min.) or oral (ca. 30 min.) exam **Examination requirements:** Key concepts and calculations from homogeneous cosmology: Newtonian cosmology; relativistic homogeneous isotropic cosmology; horizons and distances; the hot universe; Newtonian inhomogeneous cosmology; inflation. This course will be based on video lectures and short quizzes that will be discussed in class.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Jens Carsten Niemeyer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 3
Maximum number of students: 20	

Additional notes and regulations: Schwerpunkt: Astro-/Geophysik; Kern-/Teilchenphysik

Georg-August-Universität Göttingen Module B.Phy.5544: Introduction to Turbulence	3 C 2 WLH
Learning outcome, core skills: **Learning objectives:** In this course, the students will be introduced to the phenomenon of turbulence as a complex system that can be treated with methods from non-equilibrium statistical mechanics. The necessary statistical tools will be introduced and applied to obtain classical and recent results from turbulence theory. Furthermore, current numerical and experimental techniques will be discussed. **Competencies:** The students shall gain a fundamental understanding of turbulent flows as a problem of non-equilibrium statistical mechanics. Part of the course will be held in tutorial style in which textbook problems will be discussed in detail. The course shall also strengthen the students' ability to perform interdisciplinary work by stressing the interdisciplinary aspects of the field with connections to pure and applied math as well as engineering sciences.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Introduction to Turbulence (Lecture)	
Examination: Written exam (90 min.) or oral exam (approx. 30 min.) **Examination requirements:** Basic knowledge and understanding of the material covered in the course such as: continuum description of fluids (Navier-Stokes equations), non-dimensionalization & dimensional analysis, Kolmogorov phenomenology, intermittency, exact statistical approaches & the closure problem, soluble models of turbulence.	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic Knowledge in continuum mechanics or electrodynamics
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module B.Phy.5546: Excursion: Astronomical Observing Course**	6 C 4 WLH
Learning outcome, core skills: Advanced knowledge about observation planning and execution as well as data analysis and presentation of results.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Astronomical Observing Course (Excursion)	4 WLH
Examination: Poster presentation on a self-chosen research topic (approx. 15 min.) **Examination prerequisites:** Regular Participation in the excursion and the weekly preparation tutorials and data analysis sessions. **Examination requirements:** Advanced knowledge about observation planning and execution as well as data analysis and presentation of results.	

Admission requirements: none	**Recommended previous knowledge:** B.Phy.1551: Introduction to Astrophysics
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Dreizler Dr. Tim-Oliver Husser, Dr. Fabian Göttgens
Course frequency: each winter semester, depending on availability of observing time	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 10	

Georg-August-Universität Göttingen **Modul B.Phy.5601: Theoretical and Computational Neuroscience I** *English title: Theoretical and Computational Neuroscience I*	3 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • ein vertieftes Verständnis folgender Themen entwickelt haben: TCN I: biophysikalische Grundlagen neuronaler Anregbarkeit, mathematische Grundlagen neuronaler Anregbarkeit, Input-Output Beziehungen und Bifurkationen, Klassifizierung, Existenz, Stabilitaet und Koexistenz sychroner und asynchroner Zustaende in spikenden neuronalen Netzwerken; • Methoden und Methodenentwicklung für die Analyse hochdimensionaler Modelle ratenkodierter Einheiten in Feldmodellen verstehen; • die Handhabung von Bifurkationsszenarien und zugehörigen Instabilitäten verstanden haben.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Collective Dynamics Biological Neural Networks I (Vorlesung)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	3 C
Prüfung: Mündlich Mündliche Prüfung (ca. 30 Minuten)	3 C
Prüfung: Vortrag (2 Wochen Vorbereitungszeit) (30 Minuten)	3 C

Prüfungsanforderungen: Grundlagen der Membranbiophysi;, Bifurkationen anregbarer Systeme; Verständnis der Grundlagen der Modellierungsansätze der Neurophysik; kollektive Zustände spikender neuronaler Netzwerke; insbesondere Synchonizität; Balanced State; Phase-Locking und diesen Zuständen unterliegenden lokalen und Netzwerkeigenschaften: Netzwerktopologie; Delays; inhibitorische und exzitatorische Kopplung; sparse random networks	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Fred Wolf
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Modul B.Phy.5602: Theoretical and Computational Neuroscience II** *English title: Theoretical and Computational Neuroscience II*	3 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten Studierende... • das vertiefte Verständnis folgender Themen entwickelt haben: TCN II: Grundlagen neuronaler Anregbarkeit, Input-Output Beziehungen bei Einzelneuronen, eindimensionale Feldmodelle (Feature Selectivity, Contrastinvariance), zweidimensionale Feldmodell (Zusammenwirken von kurz- und langreichweitigen Verbindungen sowie lokaler Nichtlinearitaeten), Amplitudengleichungen und ihre Loesungen; • Methoden und Methodenentwicklung für die Analyse spikender neuronaler Netzwerke mit und ohne Delays, Handhabung von Bifurkationsszenarien und zugehörigen Instabilitäten verstehen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Collective Dynamics Biological Neural Networks II (Vorlesung)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	3 C
Prüfung: Mündlich (ca. 30 Minuten)	3 C
Prüfung: Seminarvortrag (2 Wochen Vorbereitungszeit) (30 Minuten)	3 C

Prüfungsanforderungen: Ratenmodelle von Einzelneuronen; Feldansatz in der theoretischen Neurophysik; Grundlagen der Bifurkationen anregbarer System; Verständnis der Grundlagen der Modellierungsansätze der Neurophysik; Zusammenhang diskrete/kontinuierliche Modelle; kollektive Zustände ein- und zweidimensionaler Feldmodelle, insbesondere ring model of feature selectivity; orientation preference maps.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Fred Wolf
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1
Maximale Studierendenzahl: 90	

Georg-August-Universität Göttingen **Modul B.Phy.5603: Einführung in die Laserphysik** *English title: Introduction to laserphysics*	3 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über folgende Grundkenntnisse: • Die dem Laser zugrundeliegenden Prinzipien. • Die Beschreibung des Laserprozesses durch Ratengleichungen sowie stationäre und zeitabhängige Lösungen derselben. • Stabilität von Laserresonatoren sowie Eigenschaften der aus Ihnen emittierten Strahlung. • Aufbau und Eigenschaften unterschiedlicher Lasertypen. • Ausgewählte Laserprobleme (Linienbreite, Hole Burning, Kurze Pulse, …)	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Vorlesung *Inhalte*: Das Prinzip des Lasers wird aufbauend auf einfachen Grundbegriffen entwickelt, dabei aber keineswegs auf quantitative Aussagen verzichtet. Im Mittelpunkt stehen die Analyse des stationären und zeitabhängigen Verhaltens von Lasern mit Hilfe des Ratengleichungsmodelles sowie die Diskussion optischer Resonatoren. Weiterhin werden die physikalischen Grundideen am Beispiel der wichtigsten Lasertypen herausgearbeitet. Eine einführende Behandlung einiger ausgewählter Probleme (Linienbreite, Hole Burning, Kurze Pulse, …) rundet die Vorlesung ab.	
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsanforderungen:** Laserprinzip; Ratengleichungen; Funktionsweise von Lasern (Festkörper, Farbstoff, Gas, Halbleiter und Freier-Elektronen); Wellengleichung; strahlen- und wellenoptische Behandlung von Resonatoren. Entwicklung des Laserprinzips aus einfachen Grundbegriffen: Licht und Materie, Laserprinzip, Ratengleichungen, Lasertypen, optische Resonatoren, ausgewählte Themen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** apl. Prof. Dr. Alexander Egner
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 4
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module B.Phy.5604: Foundations of Nonequilibrium Statistical Physics**	3 C 2 WLH

Learning outcome, core skills: **Lernziele**: Invariant densities of phase-space flows with local and global conservation of phase-space volume; reduction of a microscopic dynamics to a stochastic description, to kinetic theory and to hydrodynamic transport equations; fluctuation theorems; Green-Kubo relations; local equilibrium; entropy balance and entropy production; the second law; statistical physics of equilibrium processes as a limit of a non-equilibrium processes; applications in nanotechnology and biology: small systems far from thermodynamic equilibrium. **Kompetenzen**: After successful completion of the modul the students should know modeling approaches for a statistical-physics description of small systems far from thermodynamic equilibrium: in homework problems, that will be presented in a subsequent symposium, this will be highlighted by explicitly working out examples in nanotechnology and biology.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: lecture	
Examination: Presentation (approx. 30 min) and handout (max. 4 pages)	3 C

Examination requirements: Modeling of an experimental system by a Master equation, kinetic theory or Non-Equilibrium Molecular Dyanamics with discussion of the appropriate fluctuation relations and/or the relation of models on different levels of coarse graining.	

Admission requirements: none	**Recommended previous knowledge:** Statistische Physik
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 20	

Georg-August-Universität Göttingen Module B.Phy.5605: Computational Neuroscience: Basics	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Goals: Introduction to the different fields of Computational Neuroscience: • Models of single neurons, • Small networks, • Implementation of all simple as well as more complex numerical computations with few neurons. • Aspects of sensory signal processing (neurons as ‚filters'), • Development of topographic maps of sensory modalities (e.g. visual, auditory) in the brain, • First models of brain development, • Basics of adaptivity and learning, • Basic models of cognitive processing. **Kompetenzen/Competences:** On completion the students will have gained… • … overview over the different sub-fields of Computational Neuroscience; • … first insights and comprehension of the complexity of brain function ranging across all sub-fields; • … knowledge of the interrelations between mathematical/modelling methods and the to-be-modelled substrate (synapse, neuron, network, etc.); • … access to the different possible model level in Computational Neuroscience.	Attendance time: 28 h Self-study time: 62 h

Course: Computational Neuroscience: Basics (Lecture)	
Examination: Written examination (45 minutes) **Examination requirements:** Actual examination requirements: Having gained overview across the different sub-fields of Computational Neuroscience; Having acquired first insights into the complexity of across the whole bandwidth of brain function; Having learned the interrelations between mathematical/modelling methods and the to-be-modelled substrate (synapse, neuron, network, etc.) Being able to realize different level of modelling in Computational Neuroscience.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Bachelor: 2 - 6; Master: 1 - 4

Georg-August-Universität Göttingen **Module B.Phy.5607: Seminar: Mechanics and dynamics of the cytoskeleton**	4 C 2 WLH

Learning outcome, core skills: After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar: Mechanics and dynamics of the cytoskeleton	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Polymer physics and polymer networks; membranes; physics on small scales; cell mechanics; molecular motors; cell motility; dynamics in the cell.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5608: Micro- and Nanofluidics**	3 C 2 WLH

Learning outcome, core skills: Students will learn the fundamentals of fluid dynamics, hydrodynamics on the micro- and nanoscale, wetting and capillarity and “life” at low Reynolds numbers. Students will also learn the how these topics are studied/applied in experiments, learn about device fabrication using soft lithography and the use of fluidics in biology and biophysics including “lab-on-a-chip” applications. After successfully completing this course, students will be familiar with basic hydrodynamics and their applications at scales applicable to biology, biophysics, material sciences and biotechnology.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Micro- and Nanofluidics (Lecture)	

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examination (60 minutes)	3 C
Examination: Oral examination (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: every 4th semester; summerterm, in even years	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5611: Optical spectroscopy and microscopy**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome**: Physical basics of fluorescence and fluorescence spectroscopy, fluorescence anisotropy, fluorescence lifetime, fluorescence correlation spectroscopy, basics of optical microscopy, resolution limit of optical microscopy, wide field and confocal microscopy, super-resolution microscopy. **Core skills:**The students shall learn the basics and applications of advanced fluorescence spectroscopy and microscopy, including single-molecule spectroscopy and all variants of super-resolution fluorescence microscopy.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Fundamental understanding oft he physics of fluorescence and the applications of fluorescence in spectroscopy and microscopy.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5613: Soft Matter Physics**	3 C 2 WLH
Learning outcome, core skills: **Learning objectives** After successfully finishing this course, students will be familiar with fundamental concepts of soft condensed matter physics and their applications. Topics include: intermolecular interactions; phase transitions; interface physics; amphiphilic molecules; colloids; polymers; polymer networks; gels; fluid dynamics; self-organization. **Learning outcomes:** Students will be able to apply these fundamental concepts independently to specific questions. They will be able to use the knowledge learned to critically evaluate the current literature.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Soft Matter Physics (Lecture)	2 WLH
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examinationwritten exam (120 minutes)	3 C
Examination: Oral examinationoral exam (approx. 30 minutes)	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to…Biophysics or/and Physics of complex systems or/and Solid State Physics or/and Materials Physics
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: every 4th semester; summerterm, in odd years	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5614: Proseminar Computational Neuroscience**	4 C 2 WLH
Learning outcome, core skills: After successful completion of the module, students have deepened their knowledge in computational neuroscience / neuroinformatics by independent preparation of a topic. They should... - know and be able to apply methods of presentation of topics from computer science; - be able to deal with (English-language) literature; - be able to present a topic of computer science; - be able to lead a scientific discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Proseminar	
Examination: Talk (approx. 45 Min.) with written report (max. 7 S.) **Examination requirements:** Proof of the acquired knowledge and skills to deal with scientific literature from the field of computational neuroscience / neuroinformatics under guidance by presentation and preparation.	4 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5605
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 3
Maximum number of students: 14	

Georg-August-Universität Göttingen Module B.Phy.5617: Seminar: Physics of soft condensed matter	4 C 2 WLH
Learning outcome, core skills: After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar: Physics of soft condensed matter	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Intermolecular interactions; phase transitions; interface physics; amphiphilic molecules; colloids; polymers; polymer networks; gels; fluid dynamics; self-organization.	4 C

Admission requirements: none	**Recommended previous knowledge:** • Introduction to Biophysics and/or • Introduction to Complex Systems and/or • Introduction to Solid State Physics and/or • Introduction to Materials Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5618: Seminar to Biophysics of the cell - physics on small scales**	4 C 2 WLH

Learning outcome, core skills: After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Physical principles in cells; adhesion; motility; cellular communication; signal transduction; biopolymers and networks; nerve cinduction; extracellular matrix; experimental methods; current research.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophyiscs and/or Introduction to Physics of Complex Systems
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5619: Seminar on Micro- and Nanofluidics**	4 C 2 WLH
Learning outcome, core skills: After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar on Micro- and Nanofluidics (Seminar)	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Fluid dynamics, hydrodynamics on the micro- and nanoscale and its applications in biology, biophysics, material sciences and biotechnology; wetting and capillarity; “life” at low Reynolds numbers; soft lithography; fluidics in biology and biophysics, “lab-on-a-chip” applications; Navier-Stokes-Equation.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: German, English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen Module B.Phy.5620: Physics of Sports	4 C 2 WLH
Learning outcome, core skills: After completing this module a student should be able to: • Research a topic in the scientific literature and analyse it critically. • Show fundamental skills in model building and, for example, in the discussion of nonlinear differential equations or other complex physical models.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar	
Examination: Presentation with discussion (approx. 45 minutes) and supplementary report (max. 4 pages) **Examination prerequisites:** Active participation	
Examination requirements: The student should: Present a summary of the key physics underlying a particular sport; Explain the topic from intuition to a deep description of the relevant physical facts or foundation; Set up an appropriate model and discuss the solution. Where appropriate, the student must take into account a critical discussion of the relevant literature.	

Admission requirements: none	**Recommended previous knowledge:** Basic analytical mechanics and fluid dynamics.
Language: English, German	**Person responsible for module:** Prof. Dr. Stephan Herminghaus Contact persons: Dr. O. Bäumchen, Dr. M. Mazza
Course frequency: unegular, two year as required	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen Module B.Phy.5623: Theoretical Biophysics	6 C 4 WLH
Learning outcome, core skills: **Learning outcome:** Basics of probability theory, Bayes Theorem, Brownian motion, stochastic differential equations, Langevin equation, path integrals, Fokker-Planck equation, Ornstein-Uhlenbeck processes, thermophoresis, chemotaxis, Fluctuation Dissipation Theorems, Stochastic Resonance, Thermal Ratchet, motor proteins, hydrodynamics at the nanoscale, population dynamics, Jarzynski relations, non-equilibrium thermodynamics, neural networks. **Core skills:** The core coal is to teach students fundamental theoretical concepts about stochastic systems in the widest sense, an the application of these concepts the biophysics of biomolecules, cells and populations.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Vorlesung mit Selbststudium Literatur	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Derivation of fundamental relations describing stochastic systems, derivation, handling and explanation of differential equations, derivation of analytical and approximative solutions for the various considered problems.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Jörg Enderlein
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen Module B.Phy.5624: Introduction to Theoretical Neuroscience	4 C 2 WLH
Learning outcome, core skills: After successfully completing this course, students should understand and be able to employ the fundamental concepts, model representations and mathematical methods of the theoretical physics of neuronal systems.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar	
Examination: Lecture (approx. 60 minutes) **Examination prerequisites:** Active Participation **Examination requirements:** Elementary knowledge of the construction, biophysics and function of nerve cells; probabilistic analysis of sensory encoding; simple models of the dynamics and information processing in networks of biological neurons; modelling of the biophysical foundations of learning processes.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Fred Wolf
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module B.Phy.5625: X-ray physics**	6 C 4 WLH
Learning outcome, core skills: Knowledge in: • Radiation-matter interaction • Dosimetry, radiobiology and radiation protection • Scattering experiments: photons, neutrons and electrons • Fundamental concepts in diffraction and Fourier theory • Structure analysis in crystalline and non-crystalline condensed matter • Generation of x-rays and synchrotron radiation • X-rays optics and detection • X-ray spectroscopy, microscopy and imaging After taking the course, students • will integrate fundamental concepts of matter-radiation interaction . • are able to apply quantitative scattering techniques with short wavelength radiation for structure analysis of condensed matter, including problems in solid state, materials, soft matter, and biomolecular physics • are able to plan and carry out x-ray laboratory experiments • are prepared to participate in beamtimes at synchrotron, neutron or free-electron radiation sources • can solve analytical problems in x-ray optics, diffraction and imaging	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: X-ray Physics	
Examination: Written examination (120 minutes) or oral examination (ca. 30 min.) or presentation (ca. 30 min.) **Examination prerequisites:** none **Examination requirements:** • solve problems of the topics mentioned above on a quantitative level, including calculations of structure factor, correlation functions, • applications of Fourier theory to structure analysis and basic solutions to the phase problem, • solve problems of wave optical propagation and diffraction • knowledge about interaction mechanisms and order -of-magnitude estimations, • knowledge about theoretical concepts and experimental implementations of different techniques, • knowledge of laboratory skills (x-ray sources, detection, dosimetry)	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Tim Salditt

Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 15	

Georg-August-Universität Göttingen **Module B.Phy.5629: Nonlinear dynamics and time series analysis**	6 C 4 WLH
Learning outcome, core skills: Sound knowledge and practical experience with methods and concepts from Nonlinear Dynamics and Time Series Analysis, mainly obtained by devising, implementing, and running algorithms and simulation programs.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Blockpraktikum	
Examination: Presentation with discussion (approx. 45 minutes) and written elaboration (max. 10 pages) **Examination requirements:** • Presentation of a specific topic • Report about own (simulation) results obtained for the specific topic	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic programming skills (for the exercises)
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Ulrich Parlitz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 12	

Additional notes and regulations: (Duration: 2 weeks with 8h per day)

Georg-August-Universität Göttingen **Module B.Phy.5631: Self-organization in physics and biology**	4 C 2 WLH
Learning outcome, core skills: **Learning outcome**: basics of self-organization, non-equilibrium dynamics, cell migration, cilia dynamics and cardiac dynamics. **Core skills:** Upon successful seminar participation, the students should be capable of - accomplish literature research autonomously and therefore understand and analyse scientifc articles in the corresponding scientific context - create a presentation including physical and biological basics relevant to the scientific article and give the oral presentation	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar	
Examination: Presentation (approx. 45 Min.) **Examination prerequisites:** Active Participation **Examination requirements:** Elaborated presentation, which includes an introduction to the necessary basics	4 C

Admission requirements: none	**Recommended previous knowledge:** -Introduction to biophysics -Introduction to physics of complex systems
Language: English	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 12	

Georg-August-Universität Göttingen **Module B.Phy.5632: Current topics in turbulence research**	4 C 2 WLH
Learning outcome, core skills: **Learning outcome:** Based on a selected topic the students shall develop a basic understanding of turbulent flows. **Core skills**: The goal of this course is to enable the students to present their research in the context of the international state of the art of the field.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar	WLH
Examination: Presentation (approx. 45 Min.) **Examination prerequisites:** Active Participation **Examination requirements:** Basic understanding of turbulence; instabilities, scaling, models of turbulence, turbulence in rotating and stratified systems, turbulent heat transport, particles in turbulence	4 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of advanced continuum mechanics or electrodynamics.
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 15	

Georg-August-Universität Göttingen **Module B.Phy.5639: Optical measurement techniques**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students should ... • be able to apply light models • have understood basic optical principles of measurement • have gained an overview of optical measurement method for measuring different physical quantities at different scales	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Optical Measurement Techniques (Lecture)	
Examination: Presentation with discussion (approx. 30 min.) or oral examination (approx. 30 Min.) **Examination requirements:** Understanding optical measurement principles and methods	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik / Ansprechpartner: Dr. Nobach
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen Module B.Phy.5645: Nanooptics and Plasmonics	3 C 2 WLH
Learning outcome, core skills: After the course, the students should have a profound knowledge about the rapidly evolving field nanooptics and plasmonics, both experimentally as well as theoretically.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Nanooptics and Plasmonics (Lecture)	
Examination: Written examination (90 min.) or oral examination (approx. 30 Min.) **Examination requirements:** Electrodynamics of single particle/molecule emission, electrodynamic interaction of nano-emitters and molecules with light, interaction of light with nanoscale dielectric and plasmonic structures, and with optical metamaterials. Theory of light-matter interaction at the nanometer length scale. Fundamentals of optical microscopy and spectroscopy, applied to optical quantum emitters.	3 C

Admission requirements: none	**Recommended previous knowledge:** Experimental Physics I-IV
Language: German, English	**Person responsible for module:** Prof. Dr. Jörg Enderlein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5646: Climate Physics**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome: This course will introduce the physical principles of the Earth's climate, and the dynamics of our atmosphere and oceans. We will show how the basic features of a climate system can be understood through a detailed energy balance. A momentum balance, in the form of the Navier-Stokes equations, and mass balance, give rise to many of the additional behaviours of a real climate system. The main features of atmospheric and ocean circulation, mixing, and transport will be discussed in this context, including such topics as the thermohaline circulation; turbulent mixing; atmospheric waves; and Coriolis effects. We will then return to the global energy budget, and discuss physically grounded models of climate prediction and climate sensitivity (e.g. Milankovitch cycles), as well as their implications. In the latter part of the course, additional context on related questions of current research will be covered in special topics presented by members of the Göttingen Research Campus. **Core skills:** After successful completion of the modul the students should ... • know how to approach the study of climate in planetary systems from a rigorous physical perspective; • know which factors influence the climate, and how to analyse climate patterns and stability; • be able to develop a familiarity with the principles of climate science, and apply these to a broad range of situations, from the large-scale convection patterns in atmospheres and oceans, to the impact of clouds and precipitation, and box models for the energy and entropy budget.	Attendance time: 56 h Self-study time: 124 h

Course: Lecture with exercises	
Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Profound geophysical basis for the work on issues of climate physics.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basics of Hydrodynamics
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Jürgen Vollmer
Course frequency: two year as required, winter term or summer term	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

<table>
<tr><td>Georg-August-Universität Göttingen
Module B.Phy.5647: Physics of Coffee, Tea and other drinks</td><td>4 C
2 WLH</td></tr>
<tr><td>Learning outcome, core skills:
After completing this module a student should be able to:
• Research a topic in the scientific literature and analyse it critically.
• Show fundamental skills in model building and, for example, in the discussion of nonlinear differential equations or other complex physical models.
• Understand the phase behaviour of two (or more) component mixtures, the kinetics of phase separation, the physics of multi-phase fluids and soft materials such as foams and gels.</td><td>Workload:
Attendance time:
28 h
Self-study time:
92 h</td></tr>
<tr><td>Course: Physics of Coffee, Tea and other drinks (Seminar)</td><td></td></tr>
<tr><td>Examination: Presentation with discussion (approx. 45 minutes) and written elaboration (max. 4 pages)
Examination prerequisites:
Active Participation
Examination requirements:
Presentation of a complex physical summary of the key physics underlying a mixed drink, or other beverage (e.g. drainage of foam in espresso, slow waves and convective stripes in latte macchiato, bubble formation and growth in champagne). Where appropriate, the student must take into account a critical discussion of the relevant literature.</td><td>4 C</td></tr>
</table>

Admission requirements: none	**Recommended previous knowledge:** Basic analytical mechanics and fluid dynamics
Language: German, English	**Person responsible for module:** Prof. Dr. Stephan Herminghaus Contact Person: Dr. M. Mazza
Course frequency: unregular, two year as required	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module B.Phy.5648: Theoretical and Computational Biophysics**	4 C 2 WLH

Learning outcome, core skills: This combined lecture and hands-on computer tutorial focuses on the basics of computational biophysics and deals with questions like "How can the particle dynamics of thousands of atoms be described precisely?" or "How does a sequence alignment algorithm function?" The aim of the lecture with exercises is to develop a physical understanding of those "nano maschines" by using modern concepts of non-equilibrium thermodynamics and computer simulations of the dynamics on an atomistic scale. Moreover, the lecture shows (by means of examples) how computers can be used in modern biophysics, e.g. to simulate the dynamics of biomolecular systems or to calculate or refine a protein structure. No cell could live without the highly specialized macromolecules. Proteins enable virtually all tasks in our bodies, e.g. photosynthesis, motion, signal transmission and information processing, transport, sensor system, and detection. The perfection of proteins had already been highly developed two billion years ago. During the exercises, the knowledge presented in the lecture will be applied to practical examples to further deepen and strengthen the understanding. By completing homework sets, which will be distributed after each lecture, additional aspects of the addressed topics during the lecture shall be worked out. The homework sets will be collected during the corresponding exercises.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Theoretical and Computational Biophysics (Lecture, Exercise)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Protein structure and function, physics of protein dynamics, relevant intermolecular interactions, principles of molecular dynamics simulations, numeric integration, influence of approximations, efficient algorithms, parallel programing, methods of electrostatics, protonation balances, influence of solvents, protein structure determination (NMR, X-ray), principal component analysis, normal mode analysis, functional mechanisms in proteins, bioinformatics: sequence comparison, protein structure prediction, homology modeling, and hands-on computer simulation.	4 C

Admission requirements: none	**Recommended previous knowledge:** • Introduction to Biophysics • Introduction to Physics of Complex Systems
Language: English, German	**Person responsible for module:** Hon.-Prof. Dr. Karl Helmut Grubmüller
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students:	

30	

Georg-August-Universität Göttingen **Module B.Phy.5649: Biomolecular Physics and Simulations**	4 C 2 WLH

Learning outcome, core skills: **Learning objectives:** This combined lecture and hands-on computer tutorial offers the possibility to deepen the knowledge about theory and computer simulations of biomolecular systems, particularly proteins, and can be understood as continuation of the lecture with exercises "Theoretical and Computational Biophysics" (usually taking place in the previous winter semester). During the exercises, the knowledge presented in the lecture will be applied to practical examples to further deepen and strengthen the understanding. By completing homework sets, which will be distributed after each lecture, additional aspects of the addressed topics during the lecture shall be worked out. The homework sets will be collected during the corresponding exercises. **Competencies:** Whereas the winter term lecture with exercises "Theoretical and Computational Biophysics" emphasized the principles of running and analysing simple atomistic force field-based simulations, this advanced course will broaden our view and introduce basic principles, concepts and methods in computational biophysics, particularly required to understand biomolecular function, namely thermodynamic quantities such as free energies and affinities. Further, inclusion of quantum mechanical simulation techniques will allow to also simulate chemical reactions, e.g., in enzymes.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Lecture with Exercises Biomolecular Physics and Simulations	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Basic knowledge and understanding of the material covered in the course such as: Free energy calculations, Rate Theory, Non-equilibrium thermodynamics, Quantum mechanical methods (Hartree-Fock and Density Functional Theory), enzymatic catalysis; “handson” computational calculations and simulations	4 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5648 Theoretical and Computational Biophysics
Language: English, German	**Person responsible for module:** Hon.-Prof. Dr. Karl Helmut Grubmüller
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5651: Advanced Computational Neuroscience**	3 C 2 WLH

Learning outcome, core skills: Participants in the course can explain and relate biological foundations and mathematical modelling of selected (neuronal) algorithms for learning and pattern formation. Based on the the algorithms' properties, they can discuss and derive possible technical applications (robots).	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Advanced Computational Neuroscience I (Lecture)	
Examination: Written examination (90 Min.) or oral examination (approx. 20 Min.) **Examination requirements:** Algorithms for learning: • Unsupervised Learning (Hebb, Differential Hebb), • Reinforcement Learning, • Supervised Learning Algorithms for pattern formation. Biological motivation and technical Application (robots).	3 C

Admission requirements: none	**Recommended previous knowledge:** Basics Computational Neuroscience
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

Additional notes and regulations: Hinweis: Die B.Phy.5652 kann als vorlesungsbegleitendes Praktikum besucht werden.

Georg-August-Universität Göttingen **Module B.Phy.5652: Advanced Computational Neuroscience II**	3 C 2 WLH
Learning outcome, core skills: Participants in the course can implement, test, and evaluate the properties of selected (neuronal) algorithms for learning and pattern formation.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Advanced Computational Neuroscience II	
Examination: 4 Protocols (max. 3 Pages) and Presentations (ca. 10 Min.), not graded **Examination requirements:** Algorithms for learning: • Unsupervised Learning (Hebb, Differential Hebb), • Reinforcement Learning, • Supervised Learning Algorithms for pattern formation. Biological motivation and technical Application (robots). *For each of the 4 programming assignments 1 protocol (ca. 3 pages) and 1 oral presentations (demonstration and discussion of the program, ca. 10 min).*	3 C

Admission requirements: B.Phy.5651 (can be taken in parallel to B.Phy.5652)	**Recommended previous knowledge:** Programming in C++, basic numerical algorithms, Grundlagen Computational Neuroscience B.Phy.5504: Computational Physics (Scientific Computing)
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 24	

Georg-August-Universität Göttingen **Modul B.Phy.5655: Komplexe Dynamik physikalischer und biologischer Systeme** *English title: Complex dynamics of physical and biological systems*	4 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollen die Studierenden in Lage sein, sich ausgewählte Themen und Fragestellungen anhand von Publikationen in Fachzeitschriften oder Büchern zu erarbeiten und einem Vortrag vorzustellen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Komplexe Dynamik physikalischer und biologischer Systeme (Seminar)	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** aktive Teilnahme **Prüfungsanforderungen:** Nichtlineare Dynamik, Biophysik, komplexe Netzwerke, erregbare Medien, Herzdynamik, Kardiomyozyten, Datenanalyse, experimentelle Techniken (z.B. Bildgebende Verfahren).	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Biophysik / Einführung in die Physik komplexer Systeme
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** apl. Prof. Dr. Ulrich Parlitz
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 2
Maximale Studierendenzahl: 20	

<table>
<tr><td>Georg-August-Universität Göttingen
Module B.Phy.5656: Experimental work at large scale facilities for X-ray photons</td><td>3 C
3 WLH</td></tr>
</table>

<table>
<tr><td>Learning outcome, core skills:
The goal of this course is to acquire the competence to perform experiments at modern synchrotron sources and free-electron-laser sources (large scale facilities) in a team; this includes the theoretical and experimental preparation of such beam times, as well as the experiment itself and the data analysis;

Competences: after successfully finishing this course, students should have the theoretical basis as well as the experimental abilities for performing modern X-ray experiments and should have applied their knowledge to specific examples from biophysics, soft matter physics and materials physics.</td><td>Workload:
Attendance time:
42 h
Self-study time:
48 h</td></tr>
</table>

<table>
<tr><td>Course: Lab Course
Contents:
Lab course during an x-ray beam time performed by the Institute for X-Ray Physics at a national or international source (in particular DESY, BESSY, XFEL, ESRF, SLS, NSLSII, SACLA, Diamond, Soleil, Elettra); students will already be involved in the preparation and will thus be well prepared for the experimental approach. At the x-ray source, they experience the technical/experimental as well as the theoretical part of the work; after the campaign, they learn modern methods of data analysis by direct interaction with the project leaders.</td><td></td></tr>
<tr><td>Examination: Written report (max. 10 p.) or oral examination (approx. 30 min.) about the finished scientific project, not graded
Examination prerequisites:
Active participation at an X-ray beam time, including preparation and post-processing
Examination requirements:
Description of the scientific project, including the theoretical background and the experimental challenges and approaches; description of the data analysis and the results; discussion within the scientific context.</td><td>3 C</td></tr>
</table>

<table>
<tr><td>Admission requirements:
none</td><td>Recommended previous knowledge:
Good basic knowledge of physics (semesters 1-4) and good or very good knowledge of biophysics and x-ray optics</td></tr>
<tr><td>Language:
German, English</td><td>Person responsible for module:
Prof. Dr. Sarah Köster
Prof. Dr. Tim Salditt</td></tr>
<tr><td>Course frequency:
each semester; every semester, depending of availability of X-ray beam times</td><td>Duration:
1 semester[s]</td></tr>
<tr><td>Number of repeat examinations permitted:
twice</td><td>Recommended semester:
Bachelor: 5 - 6; Master: 1 - 4</td></tr>
</table>

Additional notes and regulations: Maximum number of students: 2/beam time; if there are more applicants than slots, participants will be selected according to their experience and knowledge

Georg-August-Universität Göttingen Module B.Phy.5658: Statistical Biophysics	6 C 4 WLH
Learning outcome, core skills: **Objectives:** The students will learn basic concepts of statistical biophysics at the molecular, cellular and population level, as well as methods for the theoretical analysis of biophysical systems. **Competences:** After successful participation in the module, students should have working knowledge of basic concepts of statistical biophysics and be able to apply them to selected problems.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Statistical Biophysics (Lecture with integrated problem sessions) *Course frequency:* each winter semester	WLH
Examination: written examination (120 Min.) or oral examination (approx. 30 Min.) **Examination requirements:** Physical principles of biological systems on the molecular, cellular and population level, application of methods from statistical physics to biological and biophysical problems.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in biophysics and statistical physics
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5659: Seminar on current topics in theoretical biophysics**	4 C 2 WLH
Learning outcome, core skills: **Objectives:** The students will develop a basic understanding of current topics and methods of theoretical biophysics at the molecular, cellular and population level, based on selected examples. **Competences:** After completing this module, the students should be able to research a topic in theoretical biophysics in the scientific literature, analyse it critically and present it in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar on current topics in theoretical biophysics	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Presentation of a selected research topic and critical discussion of its methods and results	4 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in biophysics and statistical physics
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Additional notes and regulations:	

Georg-August-Universität Göttingen **Module B.Phy.5660: Theoretical Biofluid Mechanics**	3 C 2 WLH

Learning outcome, core skills: The course will discuss the theoretical foundations of fluid mechanics used in the study of biological systems. Important concepts in the mathematical study of fluids will be introduced and employed to investigate blood flow and circulation, the propulsion of organisms and transport facilitated by fluid flow. Students will learn to set up theoretical models for a range of biological systems involving fluids employing the Navier-Stokes equation and appropriate boundary conditions. The course will prepare the students to simplify, assess and analyze models to investigate the intricate role of fluids in biological settings.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Theoretical Biofluid Mechanics (Lecture)	
Examination: Written exam (60 minutes) or oral exam (approx. 30 minutes) **Examination requirements:** Solving Navier-Stokes equation in simple geometry, derive simplified equations from models of fluid flow and transport, explore theoretical models in limiting parameter range and assess prediction in relation to modeled biological system. The exam will be oral, if max. 20 students take part at the first date of the course. Oherwise it will be a written exam.	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of calculus and algebra
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Klumpp Contact: David Zwicker
Course frequency: every 4th semester; Every second Summerterm in Rotation to Microfluidic	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 3 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5662: Active Soft Matter**	4 C 2 WLH

Learning outcome, core skills: Students acquire in depth expertise in the discipline of Active Soft Matter, focussed on artificial and biological microswimmers in experiment and theory. Topics include self-propulsion at low Reynolds numbers, chemo-, electro-, magneto- , gravi- and phototaxis, active droplets, colloids and Janus particles, dynamics of flagellae and ciliae in bacteria and algae, interaction with interfaces and complex geometries, collective and swarming dynamics and active emulsions. Core skills include the independent study of literature on current research, and the condensation, presentation and discussion of a specific topic, which are vital skills pertaining to presenting your own research and its position in a wider research field. Students will practice the critical appreciation of current research in scientific discussion and receive feedback on their presentation skills.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Active Soft Matter (Seminar)	
Examination: Oral presentation (approx. 45 min.) and handout (4 pages max.) **Examination requirements:** Preparation, presentation and discussion of a current topic in active soft matter based on published literature. Active engagement in discussions on other student's presentations. Handouts must be submitted before the presentation.	4 C

Admission requirements: none	**Recommended previous knowledge:** introductory hydrodynamics and thermodynamics
Language: English, German	**Person responsible for module:** Prof. Dr. Stephan Herminghaus
Course frequency: every 3rd semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 26	

Additional notes and regulations: Contact: Dr. Oliver Bäumchen, Dr. Corinna Maaß,

Georg-August-Universität Göttingen **Module B.Phy.5664: Excursion to DESY and the European XFEL, Hamburg**	3 C 2 WLH
Learning outcome, core skills: **Learning goals:** Basic knowledge about mission of large scale reasearch facilities, user concept and mission of DESY and European Free-electron laser (XFEL). Basic concepts of modern accelerators (super conducting and conventional), generation of synchrotron and FEL radiation, and fields of applications. **Competencies:** Overview about research and career opportunities at DESY and XFEL and how large scale facilities can be used for research and study topics. Categorize interdisciplinary information gathered at the excursion (presentations, poster session, workshop) and place it in perspective with own study background.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Excursion to DESY and the European XFEL, Hamburg (Excursion)	
Examination: oral presentation of one of the scientific activities at DESY (approx. 20min+10min discussion), Poster on a corresponding research topic, or approx. 4 pages contribution to the excursion protocol., not graded **Examination prerequisites:** Participation in the excursion and discussion of prepared lerning material **Examination requirements:** Basic knowledge about mission of large scale reasearch facilities, user concept and mission of DESY and European Free-electron laser (XFEL). Basic concepts of modern accelerators (super conducting and conventional), generation of synchrotron and FEL radiation, and fields of applications.	3 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5625: Röntgenphysik
Language: English, German	**Person responsible for module:** Prof. Dr. Tim Salditt Prof. Dr. Sarah Köster
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 10	

Georg-August-Universität Göttingen **Module B.Phy.5665: Processing of Signals and Measured Data**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome**: • Errors, e.g. systematic vs. random, static vs. dynamic, error propagation • Extraction of relevant information (separating trends, stochastic data and affecting influences, such as noise) • Stationarity, statistical quantities and functions • Characteristics of estimators (e.g., sufficiency, ergodicity, bias freeness, efficiency), Cramer-Rao bound, Bessel's correction • Sampling (equidistant and non-uniform), Possibility of reconstruction, sampling theorem, aliasing • Signal transformations (e.g. cosine, Fourier, Hilbert, Laplace, wavelet, z transform) and signal decomposition (e.g. Proper Orthogonal Decomposition, Independent Component Analysis) • Correlation functions and spectra, Wiener-Khinchin theorem • preferred acquisition, sample weighting • Window functions, moving average **Core skills**: • Specification of a measurement (sampling rate, duration, amount of data) • Bias-free and most efficient signal and data processing of measured data • Programming in Matlab or Python	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Processing of Signals and Measured Data	2 WLH
Examination: Presentation or oral exam (ca. 30 Min.) **Examination requirements:** Efficient use of signal and image processing methods as well as statistical analysis methods.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5666: Molecules of Life – from statistical physics to biological action**	4 C 2 WLH
Learning outcome, core skills: After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk to a wide audience. They should be also able to evaluate it critically.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Molecules of Life – from statistical physics to biological action (Seminar)	
Examination: Presentation, Bachelor approx. 30 min; Master approx. 60 min	4 C

Admission requirements: none	**Recommended previous knowledge:** • Thermodynamik und statistische Mechanik and/or • Introduction to Biophysics and/or • Introduction to Physics of Complex Systems and/or • Theoretical and Computational Biophysics and/or • Biomolecular Physics and Simulations
Language: English, German	**Person responsible for module:** Hon.-Prof. Dr. Karl Helmut Grubmüller Bert de Groot, Aljaz Godec
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 15	

Georg-August-Universität Göttingen Module B.Phy.5669: Seminar on Living Matter Physics	4 C 2 WLH
Learning outcome, core skills: **Learning objectives**: The seminar is a combination of presentations by external speakers and journal club presentations by students. The students will learn about state-of-the-art theoretical and experimental research in the physics of biological and biomimetic systems, as delivered by the invited speakers in the weekly seminars of the Department of Living Matter Physics of the MPI for Dynamics and Self-Organization. Seminars will be on a wide range of topics such as biological and artificial micro-swimmers and molecular motors; collective behaviour in cellular tissues, bacterial colonies, and dense active materials; chemical activity and self-organization at the sub-cellular scale; the physics of cellular and biomimetic membranes; or information flow and stochastic thermodynamics in living systems. The students will also learn how to conduct research, prepare and deliver journal club presentations about recently published articles in these topics. **Competences**: This course will give students a broad view of the latest research on the physics of living matter, and acquaint them with how practicing researchers communicate scientific findings to each other.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar on Living Matter Physics	
Examination: One or more journal club presentations (approx. 30 mins each) depending on the number of participating students (30 minutes)	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Ramin Golestanian Dr. Jaime Agudo-Canalejo
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5670: Introduction to Magnetic Resonance Imaging**	6 C 4 WLH
Learning outcome, core skills: Introduction to magnetic resonance imaging. This includes basic knowledge about the underlying physics (e.g. nuclear spins, Larmor frequency, Zeeman effect, gyromagnetc ratio, Bloch equations, spin relaxation), technical details of an MRI scanner (e.g. static magnetic field, radio-frequency transmitter, magnetic gradient system, receiv- and transmitter coils), about acquisition and reconstruction methods and about specific medical applications (e.g. perfusion and diffusion imaging). The lecture is complemented by exercises and practical examples to strengthen the acquired knowledge.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Lecture: Introduction to Magnetic Resonance Imaging (Lecture)	WLH
Course: Exercises: Introduction to Magnetic Resonance Imaging (Exercise)	WLH
Examination: Written exam (120 min.), oral exam (ca. 30 min.), or practical project with presentation (ca. 20 min) and written report (10 pages max.), 4 weeks of preparation time **Examination requirements:** Basic knowledge about magnetic resonance imaging (physics, MRI scanner, data acquisition, reconstruction, and applications)	6 C

Admission requirements: none	**Recommended previous knowledge:** Electrodynamics, quantum mechanics
Language: English, German	**Person responsible for module:** Prof. Dr. Tim Salditt Prof. Dr. Uecker, Prof. Dr. Boretius
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 50	

Georg-August-Universität Göttingen Module B.Phy.5671: Dynamics of living systems	3 C 4 WLH
Learning outcome, core skills: The student will learn to simulate the dynamical changes observed in different living systems. Typically these systems have been already published in classical papers that develop simulations. These simulations will be reproduced as part of the course project. During the course we will use known system to translate biological functions to the underlying biochemistry. The biochemistry in turn is converted to rate equations, which typically form a system of coupled nonlinear differential equations that cannot be solved analytically. Using simple numerical approaches the students will simulate these systems to recover the behavior observed in the real, living systems. Typical examples are oscillations, pattern formations and bifurcations. The student will be able to model biological signaling cascades and diffusion problems by simple numerical approaches. This will train interdisciplinary skills, understanding of basic biological concepts, integration of physics, biology, chemistry and math. The problems are solved in groups of 2 training communication skills. Furthermore, critical analysis of the already published simulations will help understanding the strength and pitfalls of simulations in biology.	**Workload:** Attendance time: 56 h Self-study time: 34 h

Course: Lecture: Dynamics of Living Systems (Lecture)	1 WLH
Course: Computer Lab Course: Dynamics of Living Systems (Internship)	3 WLH
Examination: Oral presentation (ca. 30 min. including ca. 10 min. discussion), short report (max. 20 pages) on the project. **Examination prerequisites:** Active participation (computer lab). Generation of a running simulation. **Examination requirements:** The project prepared during the semester will be presented to the other students, hence all students have to be present during the presentations. A short report (15-20 pages) describing the project and the generated code, including a short discussion of the difficulties encountered.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Alle Prof. Betz
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 16	

Georg-August-Universität Göttingen Module B.Phy.5672: Nonlinear Dynamics	3 C 2 WLH
Learning outcome, core skills: After successfully finishing this course, students will know about and understand typical features of nonlinear systems. Furthermore, they will be familiar with basic and advanced concepts and methods of nonlinear dynamics and their applications in physics and other fields of science. In particular, students will be able to implement suitable numerical algorithms or use existing software to simulate complex and chaotic dynamical processes and to perform different forms of analyses (stability and bifurcation analysis, time series analysis and prediction, control and synchronization, estimation of fractal dimension(s), computation of Lyapunov spectra, network analysis, ..).	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Workshop and Lecture Nonlinear Dynamics	2 WLH
Examination: Oral exam (ca. 30 min.) or written exam (60 min.) or presentation (ca. 30 min, 2 weeks preparation time) **Examination requirements:** Knowledge of different topics and concepts in nonlinear dynamics covered in the course and understanding how to apply them to investigate, simulate and analyse dynamical systems, in particular using numerical tools.	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in physics; linear algebra and calculus; programming skills
Language: English, German	**Person responsible for module:** apl. Prof. Dr. Ulrich Parlitz
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5673: Cell Mechanics**	6 C 4 WLH

Learning outcome, core skills: **Learning outcome:** Basics in elasticity theory and fluid dynamics, viscoelastic materials, soft matter, polymers and complex filaments, 2D and 3D networks, passive and active microrheology, fluctuations dissipation theorem, bio membranes, membrane undulations, intermembrane and electrostatic forces, simplified cells and vesicles, dynamic filaments, growth and division, traction forces, mechanosensing, Life in crowded environments, 2D tissue dynamics, jamming, 3D tissue dynamics, mechanics in development **Core skills:** The core goal is to give a deep overview of the adaptive mechanics and coordinated force generation used by cells and cellular systems to perform various complex functions. We will focus on a deep physics understanding, coming from fundamental physical laws that are rooted in conservation laws and statistical physics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Lecture and self-studies using literature: Cell Mechanics	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Derivation of fundamental mechanics properties, including viscoelasticity, modelling of polymers and biopolymers, microrheology, membrane mechanics, 2D and 3D networks.	6 C

Admission requirements: None	**Recommended previous knowledge:** Introduction to Biophysics
Language: German, English	**Person responsible for module:** Prof. Dr. Timo Betz
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5674: Modern Image Processing**	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** Enabling the student to extract meaningful data from scientific images using self-written Python programs. The syllabus starts with standard techniques of image processing and ends with more recent developments coming from the field of machine learning. This is a hands-on course; a significant part of the time will be used for coding exercises. **Core skills:** Concepts covered include: image acquisition, intensity transfomations, color, spatial and morphological filters, image registration, feature extraction, Fast Fourier Transform, segmentation, Convolutional Neural Networks, autoencoder, semantic segmentation, surface models, tomography, stereo vision.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Lecture Modern Image Processing with in-class exercises and homework	
Examination: Oral Presentation (approx. 30 minutes) **Examination requirements:** An image processing project, demonstrating mastery of the concepts taught in this course	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** PD Dr. Matthias Schröter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5675: Machine Learning, hands-on**	4 C 3 WLH

Learning outcome, core skills: **Learning outcome:** Enabling the student to apply machine learning algorithms to solve scientific problems using self-written Python programs. The syllabus covers both more traditional techniques and deep neural networks. This is a hands-on course, a significant part of the time will be used for coding exercises. **Core skills:** Concepts covered include: data preprocessing, linear regression, regularization, logistic regression, Bayesian reasoning in ML, Gaussian Mixture Models, decision trees, random forests, support vector machines, clustering, principal component analysis, deep neural networks, convolutional neural networks, (variational) autoencoders, natural language processing, ethics and ML.	**Workload:** Attendance time: 42 h Self-study time: 78 h

Course: Machine Learning, hands-on *Contents*: Lecture with in-class exercises and homework	3 WLH
Examination: Oral examination (approx. 30 minutes) **Examination prerequisites:** At least 70% of the homework points. **Examination requirements:** a machine learning project, demonstrating mastery of the concepts taught in this course	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Klumpp PD Dr. Matthias Schröter
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 28	

Georg-August-Universität Göttingen **Module B.Phy.5676: Computer Vision and Robotics**	9 C 6 WLH
Learning outcome, core skills: After successful completion of this module, students are familiar with • the basic concepts of computer vision (CV), • low level hardware components and their functions, • building and programming a robot, and • computer vision and robotics algorithms.	**Workload:** Attendance time: 84 h Self-study time: 186 h
Course: Introduction to Computer Vision and Robotics (Lecture) *Contents*: On-Off Controller, PID Controller, Moving Average Filter, Exponential Moving Average Filter, Kalman Filter, A*, Dijkstra, RRT, Q-Learning , Inverse and Forward Kinematics, Movement Generation Methods, Smoothing and Median Filtering, Bilateral Filtering, Non-Local Means, Connected Components , Morphological Operators , Line Detection, Circle Detection, Feature Detection, Advanced image segmentation algorithms.	2 WLH
Course: Practical Course on Computer Vision and Robotics (Lecture) *Contents*: Building a robot, solving a graph problem using the robot and executing the found solution by the robot in a real-world scenario involving perception and navigation	2 WLH
Course: Tutorial on Computer Vision and Robotics (Tutorial) *Contents*: In the accompanying tutorial sessions students deepen and broaden their knowledge from the lectures	2 WLH
Examination: Written report (approx. 10 p.) and Oral Exam (approx. 30 minutes) **Examination requirements:** Written report requirements: The students must be able • to describe their project in a written report • to explain given problems and used solutions for navigation- and perception problems of robots Oral Examination requirements: The students must be able • to repeat and explain lecture material • to explain control algorithms for a robot, and • to identify and understand low level hardware components as robot sensors and actuators.	9 C

Admission requirements: none	**Recommended previous knowledge:** Programming in Python
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

three times	Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 24	

Georg-August-Universität Göttingen **Module B.Phy.5677: Seminar on Advanced Topics in Cellular Biophysics**	4 C 2 WLH

Learning outcome, core skills: The aim of this course is for students to gain a profound knowledge in a selection of the following topics in cellular biophysics: - Cell studies ("top-down") - In vitro experiments ("bottom-up") - Cytoskeleton - Biopolymers and networks - Cell mechanics - Cell dynamics - Cell adhesion - Cell motility - Force generation in biological systems After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar on Advanced Topics in Cellular Biophysics	
Examination: Presentation with scientific discussion (ca. 30 min.) and scientific discussion with the other participants **Examination requirements:** Cell studies ("top-down"), in vitro experiments ("bottom-up"), cytoskeleton, biopolymers and networks, cell mechanics, cell dynamics, cell adhesion, cell motility, force generation in biological systems	4 C

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course "Introduction to Biophysics"; Bachelor studies in physics or a related field
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5678: Seminar on Advanced Methods in Biophysics**	4 C 2 WLH

Learning outcome, core skills: The aim of this course is for students to gain a profound knowledge in a selection of the following methods and their applications in biophysics: - Imaging: Fluorescence microscopy, x-ray imaging, x-ray scattering, atomic force microscopy - Force measurements: optical tweezers, atomic force spectroscopy, traction force microscopy - Modelling After successfully finishing this course, students will be able to work on specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar on Advanced Methods in Biophysics	
Examination: Presentation with scientific discussion (ca. 30 min.) and scientific discussion with the other participants **Examination requirements:** Fluorescence microscopy, x-ray imaging, x-ray scattering, optical tweezers, atomic force microscopy and spectroscopy, modelling: methods and applications in biophysics	4 C

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course "Introduction to Biophysics"; Bachelor studies in physics or a related field
Language: English	**Person responsible for module:** Prof. Dr. Sarah Köster
Course frequency: once a year	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5679: Cell Biology Methods for Physicists**	3 C 2 WLH
Learning outcome, core skills: **Learning outcome** The aim of this course is for students to gain a profound theoretical and practical knowledge in the cell biology methods that are used in cell biophysics. Topics covered are: • Working in a sterile environment • E. coli transformation for DNA amplification, purification and sequence analysis, • Mammalian cell passaging and transfection • Cell fixation and antibody staining • Imaging by epifluorescence microscopy • Image processing. **core skills** After successfully completing this course, students will be able to • plan and perform cell biology experiments • understand and interpret microscopy images of cells	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Cell Biology Methods for Physicists (Practical course)	2 WLH
Examination: written report (max. 10 pages) **Examination requirements:** Proficiency in: • Working in a sterile environment • E. coli transformation for DNA amplification, purification and sequence analysis, • Mammalian cell passaging and transfection • Cell fixation and antibody staining • Imaging by epifluorescence microscopy • Image processing	3 C

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course *Introduction to Biophysics*; Bachelor studies in physics or a related field (is useful, but not necessary)
Language: English, German	**Person responsible for module:** Prof. Dr. Sarah Köster Contact person: Dr. Ulrike Rölleke
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 3 - 6; Master: 1 - 4
Maximum number of students:	

3	

Georg-August-Universität Göttingen **Module B.Phy.5680: Biophysics across scales**	6 C 4 WLH

Learning outcome, core skills: **learning outcome**: The aim of this course is for students to gain a profound knowledge in the following fields: • Basics in biology and chemistry (cellular components, physical chemistry, molecular biology); • Basics in soft matter physics (Random walks, Brownian motion, diffusion; polymer physics); • Methods (microscopy, scattering, optical tweezers, atomic force microscopy, microfluidics); • Biophysics across scales (structural biology – molecular scale; filaments and membranes – mesoscopic scale; active matter – mesoscopic scale; cellular scale, tissue and organ scale) **core skills:** After successfully completing this course, students will be able to • extract relevant information from scientific publications • plan biophysical experiments • analyze, plot and interpret model data sets • understand, solve and interpret physical models of biological systems • discuss state-of-the-art biophysics research results	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Biophysics across scales (Lecture)	3 WLH
Examination: Oral exam (approx. 30 min.) or written exam (60 min.) **Examination requirements:** Proficiency in: • Basics in biology and chemistry (cellular components, physical chemistry, molecular biology); • Basics in soft matter physics (Random walks, Brownian motion, diffusion; polymer physics); • Methods (microscopy, scattering, optical tweezers, atomic force microscopy, microfluidics); • Biophysics across scales (structural biology; filaments and membranes; active matter; cells, cell ensembles and tissues)	6 C

Course: Biophysics across scales: hands-on-tutorial	1 WLH

Admission requirements: none	**Recommended previous knowledge:** Successful completion of the course *Introduction to Biophysics*; Bachelor studies in physics or a related field
Language:	**Person responsible for module:**

English	Prof. Dr. Sarah Köster
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4

Georg-August-Universität Göttingen **Module B.Phy.5681: Seminar CARA: Critical analysis of research articles of cell and tissue mechanics**	4 C 2 WLH

Learning outcome, core skills: After successfully finishing this course, students will be able to critically read a research paper on the subject of cell and tissue mechanics. They will be able to present such subjects in detail by identifying strengths and weaknesses. This will be done on articles that are currently only on the preprint servers. In the second part, the participants will prepare a brief presentation if a second paper where they learn how to efficiently transmit the highlights of a recent research paper. Master students and if interested also Bachelor students will practice the skill of Peer-Reviewing a paper by writing such a peer review of the paper they had presented in more detail.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar CARA (Seminar)	2 WLH
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** Active participation **Examination requirements:** Soft matter, cell mechanics, rheology, tissue mechanics, active systems, membranes, cell motility	

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: English	**Person responsible for module:** Prof. Dr. Timo Betz
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5682: Seminar: Special Topics in Cell Mechanics**	4 C 2 WLH

Learning outcome, core skills: The aim of this course is for students to gain profound knowledge in a selection of the following topics in cellular biophysics: • Biopolymers • Soft Matter • Active and Passive Rheology • Cell mechanics • Cell dynamics • Cell motility • Force generation in biological systems This will be done by presenting a short research project that will be performed in the context of the course. After successfully finishing this course, students will be able to work out or reproduce a specific question with the help of book chapters or journal publications and to present the topic in a seminar talk.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar: Special Topics in Cell Mechanics (Seminar)	2 WLH
Examination: Presentation with a scientific discussion of a research project on the subject of cell mechanics (approx. 45 min.) **Examination prerequisites:** Active participation **Examination requirements:** Biopolymers, Soft Matter, Active and Passive Rheology, Cell mechanics, Cell dynamics, Cell motility, Force generation in biological systems.	

Admission requirements: none	**Recommended previous knowledge:** Introduction to Biophysics and/or Physics of Complex Systems
Language: English	**Person responsible for module:** Prof. Dr. Timo Betz
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Modul B.Phy.5702: Dünne Schichten** *English title: Thin Layers*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden Begriffe der Physik dünner Schichten und Schichtstrukturen anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung mit Seminar (je zur Hälfte)	
Prüfung: Vortrag (ca. 30 Minuten) **Prüfungsvorleistungen:** Aktive Teilnahme im Seminar	3 C
Prüfungsanforderungen: Oberflächen; UHV; Dünnschichtverfahren; Keimbildung und Wachstum dünner Schichten; Epitaxie; Untersuchungsmethoden; spezielle Eigenschaften dünner Schichten.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 4
Maximale Studierendenzahl: 24	

Georg-August-Universität Göttingen **Modul B.Phy.5707: Nanoscience** *English title: Nanoscience*	3 C 2 SWS
Lernziele/Kompetenzen: **Lernziele**: Electronic properties of electrons confined in low-dimensional nanostructures (2D, 1D and 0D). Experimental methods for the preparation and characterization of nanostrucures. Semiconductor materials will be on focus. **Kompetenzen**: After successful completion of the modul the students should be able to gain a knowledge basis of the relevant concepts and methods needed when dealing with nanostructures.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung	
Prüfung: Mündliche Prüfung oder Vortrag (je ca. 30 Min.)	3 C
Prüfungsanforderungen: The students should show a knowledge basis of the relevant concepts and methods needed when dealing with nanostructures. Student choice if in German or in English.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** • Quantenmechanik I • Einführung in die Festkörperphysik • Einführung in die Materialphysik
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Angela Rizzi
Angebotshäufigkeit: jedes 4. Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 5 - 6; Master: 1
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Module B.Phy.5709: Seminar on Nanoscience**	4 C 2 WLH
Learning outcome, core skills: **Lernziele**: Electronic properties of electrons confined in low-dimensional structures (2D, 1D and 0D). Experimental methods for the preparation and characterization of nanostrucures. Functional nanostructures. Devices in nanoelectronics. Semiconductor materials will be on focus. **Kompetenzen**: After successful completion of the modul the students should be able to gain a deep knowledge of a current topic in nanoscience and nanodevices from the recommended scientific literature. The student will present and discuss the topic in a Seminar.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar (Blockveranstaltung)	
Examination: Vortrag (ca. 30 Min.) - student choice if in German or in English **Examination prerequisites:** Aktive Teilnahme	4 C
Examination requirements: The students should achieve a deep knowledge of a current topic in nanoscience and nanodevices from the recommended scientific literature; the student should be able to transfer this knowledge to an audience in a seminar.	

Admission requirements: none	**Recommended previous knowledge:** • Einführung in die Festkörperphysik • Einführung in die Materialphysik • Quantenmechanik I • Nanoscience
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 2
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5714: Introduction to Solid State Theory**	6 C 6 WLH

Learning outcome, core skills: **Lernziele:** Fundamental concepts of of solid state theory, Born-Oppenheimer approximation, homogeneous electron gas, electrons in lattices, lattice vibrations, elementary transport theory **Kompetenzen:** After successful completion of the modul students should be able to describe and calculate fundamental properties of solids; understand and use the language of solid-state theory.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: lecture	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Application of fundamental concepts in solid state theory, interpretation of basic experimental observations, theoretical description of fundamental phenomena in solid state physics.	6 C

Course: exercises	2 WLH

Admission requirements: keine	**Recommended previous knowledge:** Quantum mechanics I
Language: German, English	**Person responsible for module:** Prof. Dr. Stefan Kehrein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5716: Nano-Optics meets Strong-Field Physics**	6 C 4 WLH

Learning outcome, core skills: At the end of the course, students should understand and be able to apply the basic concepts of nano-optics and strong-field physics, as well as their connection in modern research. In the accompanying exercises, numerical simulations will be developed which build on the topics discussed in the lectures. An introduction will be given to scripting in Matlab and to finite element simulations with Comsol Multiphysics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Vorlesung	2 WLH
Course: Übung	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination prerequisites:** Implementation of a task in an executable programme.	6 C

Admission requirements: none	**Recommended previous knowledge:** Experimentalphysik I-IV, Quantenmechanik
Language: German, English	**Person responsible for module:** Prof. Dr. Claus Ropers StudiendekanIn der Fakultät für Physik
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5717: Mechanisms and Materials for Renewable Energy**	6 C 4 WLH

Learning outcome, core skills: By participation in both lectures on photovoltaics and solar thermal energy, thermoelectrics and solar fuels students gain knowledge about the full spectrum of physical and chemical basics of renewable energy conversion. In addition, overlapping aspects of fundamental concepts and technological approaches have been reviewed. Students shall independently apply gained knowledge to acquire and present current research in the field.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Mechanismen und Materialien für erneuerbare Energien (Lecture)	
Examination: Poster presentation with oral examination (approx. 30 Min.) **Examination requirements:** Beherrschung der grundlegenden Begriffe, Fakten und Methoden. Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics, Introduction to materials physics
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt Prof. Dr. Christian Jooß
Course frequency: two-year as required, summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen Module B.Phy.5718: Mechanisms and Materials for Renewable Energy: Photovoltaics	4 C 2 WLH
Learning outcome, core skills: After successful completion of this module students are familiar with physical basics or photo-electric energy conversion, are able to apply fundamental concepts and gained knowledge about important materials systems of photovoltaics. In addition, important experimental methods as well as current and future technological concepts have been reviewed. Students shall independently apply gained knowledge to acquire and present current research in the field.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Mechanismen und Materialien für erneuerbare Energien: Photovoltaik (Lecture)	
Examination: Poster presentation with oral examination (approx. 30 Min.) **Examination requirements:** Beherrschung der grundlegenden Begriffe, Fakten und Methoden. Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics, Introduction to Materials physics
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt
Course frequency: zweijährig im SoSe	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5719: Mechanisms and Materials for Renewable Energy: Solar heat, Thermoelectric, solar fuel**	4 C 2 WLH

Learning outcome, core skills: Physical and chemical basics of light and heat conversion to electrical and chemical energy. • In particular:Mechanisms of solarthermic, thermoelectric, electro- and photochemical energy conversion. • Important model systems and materials. • Outlook in current research activities. Students shall independently apply gained knowledge to acquire and present current research on relevant systems.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Mechanismen und Materialien für erneuerbare Energien: Solarthermie, Thermoelektrik, solarer Treibstoff (Lecture)	
Examination: Posterpresentation with oral examination (approx. 30 Min.) **Examination requirements:** Beherrschung der grundlegenden Begriffe, Fakten und Methoden. Selbständige Erarbeitung wissenschaftlicher Publikationen und deren Präsentation.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics, Introduction to Materials Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Christian Jooß
Course frequency: two-year as required, summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5720: Introduction to Ultrashort Pulses and Nonlinear Optics**	3 C 2 WLH

Learning outcome, core skills: After successful completion of this Module students will be able to work with advanced concepts, phenomena and models of ultrashort pulses and their applications in nonlinear optics.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Introduction to Ultrashort Pulses and Nonlinear Optics (Lecture)	
Examination: Oral (approx. 30 min.) or written (90 min.) **Examination requirements:** Matter-light interaction; rate equations; continuous and pulsed laser operation; mode coupling; properties of ultrashort pulses; nonlinear susceptibility and nonlinear response of bound electrons; frequency doubling; parametric amplification; self-focusing; self-phase modulation; high-harmonic generation	3 C

Admission requirements: none	**Recommended previous knowledge:** • Elektrodynamic (Experimentalphysics II) • Optic and waves (Experimentalphysics III)
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Dirk Mathias
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.Phy.5721: Information and Physics**	6 C 6 WLH
Learning outcome, core skills: Understanding the concept of information in classical physics and quantum physics, in depth understanding of the second law of thermodynamics and its generalizations with the Landauer erasure principle, learning key elements of quantum information theory and quantum computation	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Information and Physics (Lecture, Exercise)	
Examination: Written examination (120 minutes) **Examination requirements:** Understanding the concepts of classical and quantum information science, performing calculations in classical and quantum information science and interpreting the results	6 C

Admission requirements: none	**Recommended previous knowledge:** Analytical Mechanics, Quantum Mechanics and Statistical Physics
Language: English	**Person responsible for module:** Prof. Dr. Stefan Kehrein
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module B.Phy.5722: Seminar on Topics in Nonlinear Optics**	4 C 2 WLH
Learning outcome, core skills: This seminar adresses some of the most important nonlinear optical phenomena and their application. Exemplary topics will be parametric processes and wave mixing, high harmonic generation, spatial and temporal solitons, supercontinuum generation, optical phase conjugation, stimulated Raman scattering, photorefractive phenomena, optical filamentation and electromagnetically induced transparency.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar on Topics in Nonlinear Optics (Seminar)	
Examination: Presentation with discussion (Bachelor approx. 30 min., Master approx. 60 min.) **Examination prerequisites:** compulsory attendance **Examination requirements:** A fundamental understanding of nonlinear optical phenomena and their application.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Claus Ropers
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module B.Phy.5723: Hands-on course on Density-Functional calculations 1**	3 C 3 WLH
Learning outcome, core skills: Students will be able to perform first-principles electronic-structure and ab-initio molecular dynamics simulations, understand the results and judge their accuracy. They will have a basic knowledge of the underlying methods. They will know simple methods of anticipating and describing electronic and atomic structure and chemical bonds.	**Workload:** Attendance time: 40 h Self-study time: 50 h
Course: Hands-on course on Density-Functional calculations 1 (Block course) *Contents*: 1. Theoretical foundation of first-principles calculations (lecture 10 h) 2. Simple concepts of electronic structure and chemical binding (lecture 10 h) 3. Hands on Course with the CP-PAW code (Exercise 20 h)	
Examination: oral (approx 30 min), presentation (30 min) or report **Examination prerequisites:** regular participation **Examination requirements:** The student is able to describe topics from the course and to respond to questions. A presentation or a report will describe a specified home project.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Bloechl
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5724: Hands-on course on Density-Functional calculations 1+2**	6 C 6 WLH
Learning outcome, core skills: Students will be able to perform first-principles electronic-structure and ab-initio molecular dynamics simulations, understand the results and judge their accuracy. They will have a basic knowledge of the underlying methods. They will know simple methods of anticipating and describing electronic and atomic structure and chemical bonds.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Hands-on course on Density-Functional calculations 1+2 (Block course) *Contents*: 1. Theoretical foundation of first-principles calculations (lecture 10 h) 2. Simple concepts of electronic structure and chemical binding (lecture 10 h) 3. Hands on Course with the CP-PAW code (Exercise ~22 h) 4. Advanced topics of first-principles calculations (lecture ~8 h) 5. Hands on Course: guided projects (~26 h) 6. Seminar on guided projects (~12 h)	
Examination: oral (approx 30 min), presentation (30 min) or report **Examination prerequisites:** regular participation **Examination requirements:** The student is able to describe topics from the course and to respond to questions. A presentation or a report will describe a specified project.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Bloechl
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module B.Phy.5725: Renormalization group theory and applications**	6 C 6 WLH

Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand concepts of field theory and renormalization group in classical and quantum systems. **Core skills:** Students will be able to use the basics of field theory, including perturbation theory and renormalization, and be able to apply these tools to physical problems.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Renormalization group theory and applications (Lecture)	4 WLH
Course: Renormalization group theory and applications (Exercise)	2 WLH
Examination: Written or oral examWritten exam (120 min) or oral exam (approx. 30 min) **Examination prerequisites:** None **Examination requirements:** Theoretical concepts of field theory, renormalization techniques, and their physical interpretation.	6 C

Admission requirements: none	**Recommended previous knowledge:** • Thermodynamik und statistische Mechanik • Quantenmechanik I
Language: English, German	**Person responsible for module:** Prof. Dr. Matthias Krüger
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Modul B.Phy.5726: Kinetik und Phasenumwandlung in Materialien** *English title: Kinetics and phase transformation in materials*	3 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden Begriffe der Nicht-Gleichgewicht-Prozesse und des Transports auf materialphysikalische Fragestellungen anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Vorlesung mit Übung	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (120 Minuten)	3 C
Prüfung: Mündlich (ca. 30 Minuten)	3 C
Prüfungsanforderungen: Analytische Verfahren zur Vereinfachung und Lösung nicht-linearer partieller Differentialgleichungen. Nicht-Gleichgewichts Thermodynamik; Transport; Diffusion; Klassifizierung von Phasenumwandlungen; Grenzflächenbewegung; morphologische Instabilitäten; Keimbildung; Wachstum; spinodale Entmischung; kinetische Umwandlungen	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Festkörperphysik Einführung in die Materialphysik
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Prof.in Cynthia Ann Volkert
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 6; Master: 1 - 4
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Module B.Phy.5805: Quantum field theory I**	6 C 6 WLH

Learning outcome, core skills: **Acquisition of knowledge:** Quantization of free relativistic wave equations (Klein-Gordon and Dirac); General properties of quantum fields; Interaction with external sources; Perturbation theory and basics of renormalization theory; Quantum Electro Dynamics and abelian gauge symmetry. **Competencies:** The students shall be familiar with the basic concepts and methods of Quantum Field Theory. They can apply them to explicit examples.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Quantum field theory I (Lecture)	4 WLH
Course: Quantum field theory I (Exercise)	2 WLH

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Examination: Written examination (120 minutes) **Examination requirements:** Solution of concrete problems treated in the lecture course. Explanation of notions and methods of Quantum Field Theory.	6 C
Examination: Oral examination (approx. 30 minutes)	6 C

Admission requirements: none	**Recommended previous knowledge:** Quantum mechanics I, II, Classical Field theory
Language: English	**Person responsible for module:** apl. Prof. Dr. Karl-Henning Rehren
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 2
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module B.Phy.5807: Physics of particle accelerators**	3 C 3 WLH
Learning outcome, core skills: After successful completion of this module, students should be familiar with the concepts, the physics (mainly electromagnetism) and explicit examples of historic and modern particle accelerators. Ideally, they should be able to simulate beam optics via numerical simulations (MatLab/SciLab).	**Workload:** Attendance time: 42 h Self-study time: 48 h
Course: Physics of particle accelerator (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Introduction to physics of particle accelerators; synchrotron radiation; linear beam optics; injection and ejection; high-frequency system for particle acceleration; radiation effects; luminosity, wigglers and undulators; modern particle accelerators based on the examples HERA, LEP, Tevatron, LHC, ILC and free electron laser FLASH/XFEL.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; unregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module B.Phy.5808: Interactions between radiation and matter - detector physics**	3 C 3 WLH

Learning outcome, core skills: After successful completion of this module, students should be familiar with a conceptional understanding of different particle detectors and the underlying interactions. They should be familiar with physics processes of particle or radiation detection in high energy physics and related fields and applications.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Interactions between radiation and matter - detector physics (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Mechanism of particle detection; interactions of charged particles and photons with matter; proportional and drift chambers; semiconductor detectors; microstrip and pixel detectors; Cherenkov detectors; transition radiation detectors; scintillation (organic crystals and plastic scintillators); electromagnetic calorimeter; hadron calorimeter.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen Module B.Phy.5810: Physics of the Higgs boson	3 C 3 WLH
Learning outcome, core skills: After successful completion of this module, students should possess a deep understanding of the Higgs mechanism, the properties of the Higgs boson, and experimental methods (concepts and concrete examples) used in investigations of the Higgs sector.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Physics of the Higgs boson (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Review of the Standard Model of particle physics; The Higgs mechanism and the Higgs potential; properties of the Standard Model Higgs boson; Experimental methods in the search for the Higgs boson at LEP, Tevatron and LHC; Discovery of the Higgs boson; Measurement of the Higgs boson couplings and other properties; Two Higgs Doublet Modells and extended Higgs sectors (in particular, the MSSM); Searches for Higgs bosons beyond the Standard Model.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen Module B.Phy.5811: Statistical methods in data analysis	3 C 3 WLH

Learning outcome, core skills: After successful completion of this module, students should be well-versed in the theoretical foundations of statistical methodology used in data analysis. This is complemented with concrete examples where statistical analysis is performed using the ROOT software package (a free C++ type software package for data analysis, which runs on Linux, Windows, and Mac operating systems).	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Statistical methods in data analysis (Lecture)	
Examination: oral exam (approx. 30 min.) or written exam (120 min.) **Examination requirements:** Concepts, methods, can concrete examples of statistical methods in data analysis: Introduction and description of data; theoretical probability density functions, including Gaussian, Poisson, and multi-dimensional distributions; parameter estimation; maximum likelihood method (and examples); chi^2 method and chi^2-distribution; optimization; hypothesis tests; classification methods; Monte Carlo methods; unfolding.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5812: Physics of the top-quark**	3 C 3 WLH
Learning outcome, core skills: Learning Objectives and Competencies: After successful completion of this module, students should be familiar with the properties and interactions of the top-quark as well as the experimental methods for its studies.	**Workload:** Attendance time: 42 h Self-study time: 48 h
Course: Physics of the top-quark (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Concepts and specific experimental methods for the discovery and studies of the top-quark. Introduction to particle physics of quarks, discovery of the top-quark, top-antitop production (theory and experiment); electroweak production of single-top quarks; top-quark mass; electric charge and spin of top-quarks; W-helicity in top-quark decay; top-quark decay in the standard modell and beyond; sensitivity to new physics; top-quark physics at the ILC, recent results of top-quark physics.	3 C

Admission requirements: keine	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul B.Phy.5815: Seminar zu einführenden Themen der Teilchenphysik** *English title: Seminar on Introductory Topics in Particle Physics*	4 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden anhand von Publikationen oder Buchkapiteln sich in Fragestellungen zu Themen der modernen Elementarteilchenphysik einarbeiten und in einem Seminarvortrag vorstellen können.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Seminar	
Prüfung: Vortrag (ca. 30 Min.) mit schriftlticher Ausarbeitung (max. 20 S.) **Prüfungsvorleistungen:** Aktive Teilnahme **Prüfungsanforderungen:** Selbständige Erarbeitung wissenschaftlicher Sachverhalte und deren Präsentation.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Kern-/Teilchenphysik
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Arnulf Quadt
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module B.Phy.5816: Phenomenology of Physics Beyond the Standard Model**	3 C 2 WLH
Learning outcome, core skills: After successful completion of this module, students understand the shortcomings and limitations of the Standard Model of Particle Physics. Students also acquire insight into the phenomenology of physics beyond the Standard Model (BSM) at TeV energy scales, particularly from models with Supersymmetry and Extra dimensions. Students will also learn the experimental signatures of BSM phenomenology at colliders along with experimental techniques and statistical methods.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Phenomenology of Physics Beyond the Standard Model (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Review of the Standard Model of particle physics; Limitations and Shortcomings of the Standard Model; Phenomenology of Supersymmetry; Phenomenology of Extra Dimensions; Other Models with New Physics; Collider Signatures of New Physics; Statistics for Experimental Searches	3 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Stanley Lai
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module B.Phy.5817: Nuclear Reactor Physics**	4 C 4 WLH

Learning outcome, core skills: After successful completion of the module students should be familiar with the physics concepts of nuclear reactors, nuclear fission and breeding, neutron kinetics, neutron diffusion and neutron balance, criticality and reactivity, delayed neutrons, temperature effects on reactivity, chemical shim and burnable poisons, fast breeders, high temperature reactors, research reactors, enrichment, nuclear fuel cycle and radioactive waste, risk management	**Workload:** Attendance time: 56 h Self-study time: 64 h

Course: Nuclear reactor physics in the field of Nuclear and Particle (Lecture)	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Physics of nuclear reactors and nuclear reactor concepts	4 C

Course: Tutorial Nuclear reactor physics in the field of Nuclear and Particle (Tutorial)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Introduction to nuclear and particle physics
Language: English, German	**Person responsible for module:** Prof. Dr. Hans Christian Hofsäss
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 5 - 6; Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen Module B.Phy.5901: Advanced Computer Simulation	6 C 4 WLH
Learning outcome, core skills: The goal of the module is to introduce advanced algorithms and program structures / design, enabling the students to write codes for more advanced tasks in computational physics from scratch (preferably in C++).	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Advanced Computer Simulation	
Examination: Oral exam (approx.30 min.) or oral presentation with discussion (approx.30 min.), 2 weeks time for preparation) or project work at home with a final report (max. 15 pages) **Examination requirements:** • Implementation and usage of advanced algorithms to solve problems in computational physics • Understanding of the algorithms • Ability to choose suitable methods for solving a given problem Topics: 1. „Design Patterns“: typical programming/design structures and strategies 2. Algorithms for quantum problems, e.g., exact diagonalization approaches, numerical renormalization group and related methods, Quantum Monte Carlo 3. Algorithms used in engineering, e.g., finite element methods 4. Algorithms for and basics of computational finance	6 C

Admission requirements: none	**Recommended previous knowledge:** Programming course, course lecture „CWR“
Language: English	**Person responsible for module:** Prof. Dr. Marcus Müller
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 6; Master: 1 - 4
Maximum number of students: 40	

Additional notes and regulations:

Georg-August-Universität Göttingen **Module B.Phy.606: Electronic Lab Course for Natural Scientists**	6 C 6 WLH

Learning outcome, core skills: Learning Objectives and Competencies: After successful completion of this module, students should be familiar with • fundamental concepts and terminology of electronics • be able to handle modern electronic devices (simple devices, basic circuits) • be able to work out and conduct a scientific project within a given time window	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: B.Phy.606. Electronic lab course for natural scientists (Internship, Lecture, Exercise) 1. Lecture with excercises 2. Lab (5 Experiments) 3. Praktikum (1 Projekt)	
Examination: Presentation with discussion (approx. 30 minutes) and written elaboration (max. 10 pages) **Examination prerequisites:** At least 50% of problem sets (homework) have to be solved (passed) **Examination requirements:** 1. fundamental concepts and terminology of electronics, 2. handling of simple electronics devices, basic circuits and functional units; 3. conceptual design and realisation of projects in electronics.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 20	

Additional notes and regulations: Block course

Georg-August-Universität Göttingen **Modul B.Phy.607: Akademisches Schreiben für Physiker/innen** *English title: Academic Writing for Physicists*	4 C 2 SWS
Lernziele/Kompetenzen: **Lernziele:** In diesem Workshop erlernen Studierende Grundkompetenzen des akademischen Schreibens in den beiden Schreibtraditionen des Deutschen und Englischen. Hierfür werden unterschiedliche Textarten (z.B. wissenschaftlicher Artikel, Essay, Protokoll, Bericht) sowie akademische Teiltexte (z.B. Einleitung – Introduction) in den beiden Schreibtraditionen analysiert und miteinander verglichen. Von diesem analytisch-rezeptiven Ansatz ausgehend vertiefen die Studierenden ihre Kenntnisse, indem sie selbst akademische Texte in beiden Schreibtraditionen verfassen, hierbei wird ein Schwerpunkt auf das Schreiben englischer akademischer Texte gelegt. **Kompetenzen:** Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden über akademische Schreibkompetenzen in englischer und deutscher Schreibtradition, Reflexionsvermögen eigener akademischer Schreibprozesse sowie Feedbackkompetenzen verfügen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Akademisches Schreiben für Physiker/innen	
Prüfung: Portfolio (max. 20 Seiten) **Prüfungsvorleistungen:** Aktive, regelmäßige Teilnahme an dem Workshop, Erledigen schriftlicher Teilleistungen	
Prüfungsanforderungen: Verfassen deutscher und englischer wissenschaftlicher Texte	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Phy.608: Scientific Literacy - Integration von Naturwissenschaften in die Gesellschaft und Politik** *English title: Scientific Literacy*	4 C 2 SWS
Lernziele/Kompetenzen: **Lernziele**: Dieses interdisziplinäre Modul soll die Kluft zwischen den Naturwissenschaften und den Geistes- und Gesellschaftswissenschaften überbrücken helfen. Die Studierenden aller Fachrichtungen sollen gemeinsam naturwissenschaftliche Erkenntniswege kennenlernen und sie anhand aktueller Themen (z.B. anthropogener Klimawandel) nachvollziehen. Hierzu werden auch Grundlagen der Wissenschaftstheorie vermittelt. **Kompetenzen**: Nach erfolgreichem Absolvieren des Moduls sollten Studierende ein Verständnis für Scientific Literacy (u.a. wissenschaftliche Nachprüfbarkeit, Unterscheidung zwischen naturwissenschaftlichen, politischen und gesellschaftlichen Komponenten einer Bewertung) entwickelt sowie Vermittlungskompetenz erworben haben.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 92 Stunden
Lehrveranstaltung: Seminar	
Prüfung: Portfolio (max. 10 Seiten) **Prüfungsvorleistungen:** Vortrag (ca. 30 Minuten) oder äquivalente Leistung sowie aktive Teilnahme **Prüfungsanforderungen:** Grundlagen der Wissenschaftstheorie; Unterscheidung zwischen naturwissenschaftlichen, politischen und gesellschaftlichen Komponenten einer Bewertung.	4 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Bachelor: 3 - 6; Master: 1 - 4
Maximale Studierendenzahl: 24	

Georg-August-Universität Göttingen **Module B.SK-Phy.9001: Papers, Proposals, Presentations: Skills of Scientific Communication**	4 C 2 WLH
Learning outcome, core skills: Goals: Handling of different presentation media (written and oral); presenting complex facts to experts and laymen; skills of communication and scientific discussion	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Papers, Proposals, Presentations: Skills of Scientific Communication (Seminar)	2 WLH
Examination: Lecture (approx. 30 minutes) **Examination prerequisites:** Active participation **Examination requirements:** Independent preparation and scientific publications and their presentation Time for preparation 4 weeks	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Ansgar Reiners
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Bachelor: 4 - 6; Master: 1 - 4
Maximum number of students: 18	

Additional notes and regulations:
Einbringbar in den Wahlbereich nicht-physikalisch.

Georg-August-Universität Göttingen **Modul M.Che.1314: Biophysikalische Chemie** *English title: Biophysical Chemistry*	6 C 5 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Abschluss des Moduls ... • sollen die Studierenden in der Lage sein, die wesentlichen physikochemischen Zusammenhänge biologischer Materie zu verstehen • die generellen Triebkräfte biologischer Reaktionen kennen • Spektroskopische Methoden zur Strukturbestimmung biologischer Makromoleküle verstehen und anwenden können • die Grundzüge moderner optischer Mikroskopie sowie der Sondenmikroskopie verstanden haben • die Mechanik und Dynamik biologischer Systeme ausgehend vom Einzelmolekül bis zur einzelnen Zelle erörtern können	**Arbeitsaufwand:** Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden
Lehrveranstaltung: Biophysikalische Chemie (Vorlesung)	3 SWS
Prüfung: Klausur (180 Minuten)	6 C
Lehrveranstaltung: Biophysikalische Chemie (Übung)	2 SWS
Prüfungsanforderungen: • Übertragung genereller physikochemischer Prinzipien, wie zum Beispiel der Reaktionsdynamik, (statistischen) Thermodynamik und Quantentheorie auf die Beschreibung biologischer Phänomene • Beschreibung biologisch relevanter Wechselwirkungskräfte, stochastischer Prozesse wie Diffusion, physikalischer Biopolymer-Modelle, der Eigenschaften von Biomembranen und der Visikoelastizität von weicher Materie. • Kenntnisse der wesentlichen Methoden, wie z.B. UV-Vis, Circulardichroismus, Rasterkraftmikroskopie, optische Fallen, Fluoreszenz, und optische Mikroskopie.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Andreas Janshoff
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** 1 - 2
Maximale Studierendenzahl: 64	

Georg-August-Universität Göttingen Ruprecht-Karls-Universität Heidelberg Module M.MtL.1006: Modern Experimental Methods	6 C 6 WLH
Learning outcome, core skills: Knowledge about advanced applied optics, radiation-matter interaction, spectroscopy, microscopy and imaging techniques in biophysics After taking this course, students will have quantitative insight into modern experimental techniques for biophysics, in particular optical techniques from basic to advances microscopy including confocal, light sheet and nanoscopy, optical spectroscopy including time-resolved techniques (transient absorption), single molecule techniques (e.g. FCS), electron microscopy, neutron and x-ray diffraction (including protein crystallography), NMR spectroscopy, and X-ray imaging. Students have the competence to reduce the complexity to underlying physics of radiation-matter interaction, to use Fourier-based methods in signal theory, concepts of wave and quantum optics, as well as quantitative data analysis. Hand-on examples of experimental applications and data recording will be introduced by short teaching units in the laboratory along with the courses, and a deeper unit of a 3 days practical in one of the technquies.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Modern Experimental Methods (Lecture, Exercise)	6 WLH
Examination: written examination (120 min.) or oral exam (approx. 30 min.) or presentation (approx. 30 min., 2 weeks preparation time) **Examination requirements:** Theoretical and practical knowledge of modern methods of experimental methods of biophysics.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Tim Salditt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: once	**Recommended semester:** 2
Maximum number of students: 15	

Additional notes and regulations: in-person in Göttingen

Georg-August-Universität Göttingen Module M.Phy.1401: Advanced Lab Course I	6 C 6 WLH
Learning outcome, core skills: After successful completion of the module, students have • familiarised themselves independently with complex issues, • performed experimental tasks under guidance in a team, • and have written scientific protocols within good scientific practice.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Advanced Lab Course I	
Examination: Oral examination (approx. 30 minutes) **Examination prerequisites:** 4 successful performed experiments. **Examination requirements:** Advanced experimental methods for solving physical problems.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1
Maximum number of students: not limited	

Georg-August-Universität Göttingen Module M.Phy.1402: Advanced Lab Course II	6 C 6 WLH

Learning outcome, core skills: After successful completion of the module, students have • familiarised themselves independently with complex issues, • performed experimental tasks under guidance in a team, • and have written scientific protocols within good scientific practice.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Advanced Lab Course II	
Examination: Oral examination (approx. 30 minutes) **Examination prerequisites:** 4 successfull performed experiments **Examination requirements:** Advanced experimental methods for solving physical problems.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 2
Maximum number of students: not limited	

Georg-August-Universität Göttingen Module M.Phy.1403: Internship	6 C 6 WLH
Learning outcome, core skills: After successful completion of the module, students should familiarise oneself independently in complex issues and perform tasks under guidance in team work. The students should be able to present the obtained results in a talk or as a poster.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Internship	
Examination: Posterpresentation (approx. 30 min.) **Examination prerequisites:** Internship **Examination requirements:** Advanced methods for solving physical problems in the area of the chosen focus.	6 C

Admission requirements: This module can be selected only on the recommendation of a lecturer.	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 2

Georg-August-Universität Göttingen **Module M.Phy.1404: Methods of Computational Physics**	6 C 6 WLH
Learning outcome, core skills: After successful completion of the module students will be familiar with the key methods and algorithms of computational physics. Students will be able to select and deploy appropriate computational approaches in order to model and analyse a range of classical and quantum systems.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Computational lab course	2 WLH
Course: Methods of Computational Physics (Lecture)	4 WLH
Examination: written (120 min.) or oral exam (approx. 30 min.) **Examination prerequisites:** Successful completion of 4 computational projects **Examination requirements:** Projects may include: Monte Carlo for phase transitions, rare event simulations, exact numerics for quantum systems, quantum Monte Carlo, simulations of disordered/glassy systems.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of equilibrium statistical mechanics and 1-particle quantum mechanics.
Language: English, German	**Person responsible for module:** Prof. Dr. Fabian Heidrich-Meisner
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 3
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.1405: Advanced Computational Physics**	6 C 6 WLH
Learning outcome, core skills: After successful completion of the module students should be familiar with the complete project cycle of advanced computational physics work. Students will be able to build and refine appropriate models for solutions of specific physical problems, select and implement advanced computational approaches using both existing software and own codes, and analyse the resulting data.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Computational lab course	
Examination: Oral examination (approx. 30 minutes) **Examination prerequisites:** Successful completion of 3 problem-driven computational projects (50% of the achievable score in each project) **Examination requirements:** Projects may include: Monte Carlo for phase transitions, rare event simulations, exact numerics for quantum systems, quantum Monte Carlo, simulations of disordered/glassy systems.	6 C

Admission requirements: none	**Recommended previous knowledge:** • *Methods of Computational Physics* • *Advanced Statistical Physics* • *Advanced Quantum Mechanics*
Language: English, German	**Person responsible for module:** Prof. Dr. Marcus Müller
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.1601: Development and Realization of Scientific Projects in Astro-/Geophysics**	9 C
Learning outcome, core skills: After successful completion of the module, students should be able to carry out the planning and the "controlling" of scientific research projects independently. They should ... • tbe able o use Literature Databases systematically; • have a good command of modern word processors; • have skills in good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 270 h
Course: Development and Realization of Scientific Projects in Astro-/Geophysics	
Examination: written report (max. 30 S.)	9 C
Examination requirements: Use of Literature Databases, good command of modern word processors	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1602: Development and Realization of Scientific Projects in Biophysics/Complex Systems**	9 C

Learning outcome, core skills: After successful completion of the module, students should be able to carry out the planning and the "controlling" of scientific research projects independently. They should ... • tbe able o use Literature Databases systematically; • have a good command of modern word processors; • have skills in good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 270 h

Course: Development and Realization of Scientific Projects in Biophysics/ Complex Systems	
Examination: written report (max. 30 S.)	9 C

Examination requirements: Use of Literature Databases, good command of modern word processors	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1603: Development and Realization of Scientific Projects in Solid State/Materials Physics**	9 C
Learning outcome, core skills: After successful completion of the module, students should be able to carry out the planning and the "controlling" of scientific research projects independently. They should ... • tbe able o use Literature Databases systematically; • have a good command of modern word processors; • have skills in good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 270 h
Course: Development and Realization of Scientific Projects in Solid State/ Materials Physics	
Examination: written report (max. 30 S.)	9 C
Examination requirements: Use of Literature Databases, good command of modern word processors	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1604: Development and Realization of Scientific Projects in Nuclear/Particle Physics**	9 C
Learning outcome, core skills: After successful completion of the module, students should be able to carry out the planning and the "controlling" of scientific research projects independently. They should ... • tbe able o use Literature Databases systematically; • have a good command of modern word processors; • have skills in good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 270 h
Course: Development and Realization of Scientific Projects in Nuclear/Particle Physics	
Examination: written report (max. 30 S.)	9 C
Examination requirements: Use of Literature Databases, good command of modern word processors	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1605: Networking in Astro-/Geophysics**	3 C
Learning outcome, core skills: **Objectives:** Formulation of proposals, registration, funding and participation in congresses **Competences:** After successful completion of the module the student should have gained networking skills.	**Workload:** Attendance time: 0 h Self-study time: 90 h
Course: Networking in Astro-/Geophysics	
Examination: written report (max. 10 S.), not graded	3 C
Examination requirements: Networking and application in scientific and professional environment on student's own initiative.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Studiendekan/in der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1606: Networking in Biophysics/Physics of Complex Systems**	3 C
Learning outcome, core skills: **Objectives:** Formulation of proposals, registration, funding and participation in congresses **Competences:** After successful completion of the module the student should have gained networking skills.	**Workload:** Attendance time: 0 h Self-study time: 90 h

Course: Networking in Biophysics/Physics of Complex Systems	
Examination: written report (max. 10 S.), not graded	3 C

Examination requirements: Networking and application in scientific and professional environment on student's own initiative.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Studiendekan/in der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1607: Networking in Solid State/Materials Physics**	3 C

Learning outcome, core skills: **Objectives:** Formulation of proposals, registration, funding and participation in congresses **Competences:** After successful completion of the module the student should have gained networking skills.	**Workload:** Attendance time: 0 h Self-study time: 90 h

Course: Networking in Solid State/Materials Physics	
Examination: written report (max. 10 S.), not graded	3 C

Examination requirements: Networking and application in scientific and professional environment on student's own initiative.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Studiendekan/in der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen **Module M.Phy.1608: Networking in Nuclear/Particle Physics**	3 C
Learning outcome, core skills: **Objectives:** Formulation of proposals, registration, funding and participation in congresses **Competences:** After successful completion of the module the student should have gained networking skills.	**Workload:** Attendance time: 0 h Self-study time: 90 h
Course: Networking in Nuclear/Particle Physics	
Examination: written report (max. 10 S.), not graded	3 C
Examination requirements: Networking and application in scientific and professional environment on student's own initiative.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Studiendekan/in der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 3 - 4
Maximum number of students: 150	

Georg-August-Universität Göttingen Module M.Phy.1609: Networking in Theoretical Physics	3 C

Learning outcome, core skills:	Workload:
Objectives: Formulation of proposals, registration, funding and participation in congresses **Competences:** After successful completion of the module the student should have gained networking skills.	Attendance time: 0 h Self-study time: 90 h

Course: Networking in Theoretical Physics	
Examination: written report (max. 10 p.), not graded	3 C

Examination requirements:	
Networking and application in scientific and professional environment on student's own initiative.	

Admission requirements: none	Recommended previous knowledge: none
Language: English, German	**Person responsible for module:** Studiendekan/in der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 3 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen Module M.Phy.1610: Development and Realization of Scientific Projects in Theoretical Physics	9 C
Learning outcome, core skills: After successful completion of the module, students should be able to carry out the planning and the implementation of scientific research projects independently. They should ... • tbe able to use Literature Databases systematically; • have a good command of modern word processors; • have skills in good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 270 h
Course: Development and Realization of Scientific Projects in Theoretical Physics	
Examination: written report (max. 30 p.)	9 C
Examination requirements: Use of Literature Databases, good command of modern word processors	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 3 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen Module M.Phy.405: Research Lab Course in Astro- and Geophysics	18 C
Learning outcome, core skills: **Learning Outcome:** By working independently within a current scientific research project students are fostered to familiarize themselves with a new advanced topic in the field of Astro-/Geophysics. They will learn to successfully perform a sub-task and finally present the reults to a professional audience. **Core skills:** Students will be able to organize, conduct, evaluate and present small, manageable projects in the field of Astro-/Geophysics, obeying the rules of good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 540 h

Course: Research Lab Course in Astro- and Geophysics	
Examination: Lecture(2 weeks preparation time) (approx. 30 minutes) **Examination requirements:** Methods for in-depth familiarisation in a scientific field of work, critical review of literature, scientific presentation, good scientific practice.	18 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Alle Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.406: Research Lab Course in Biophysics and Physics of Complex Systems**	18 C
Learning outcome, core skills: **Learning Outcome:** By working independently within a current scientific research project students are fostered to familiarize themselves with a new advanced topic in the field of Biophysics/ Complex Systems. They will learn to successfully perform a sub-task and finally present the reults to a professional audience. **Core skills:** Students will be able to organize, conduct, evaluate and present small, manageable projects in the field of Biophysics/Complex Systems, obeying the rules of good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 540 h

Course: Research Lab Course in Biophysics and Physics of Complex Systems	
Examination: Lecture(2 weeks preparation time) (approx. 30 minutes) **Examination requirements:** Methods for in-depth familiarisation in a scientific field of work, critical review of literature, scientific presentation, good scientific practice.	18 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Alle Dean of Studies of the Faculty of Physics
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.407: Research Lab Course in Solid State/Materials Physics**	18 C

Learning outcome, core skills: **Learning Outcome:** By working independently within a current scientific research project students are fostered to familiarize themselves with a new advanced topic in the field of Solid State/ Materials Physics. They will learn to successfully perform a sub-task and finally present the reults to a professional audience. **Core skills:** Students will be able to organize, conduct, evaluate and present small, manageable projects in the field of Solid State/Materials Physics, obeying the rules of good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 540 h

Course: Research Lab Course in Solid State/Materials Physics	
Examination: Lecture(2 weeks preparation time) (approx. 30 minutes) **Examination requirements:** Methods for in-depth familiarisation in a scientific field of work, critical review of literature, scientific presentation, good scientific practice.	18 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen Module M.Phy.408: Research Lab Course in Nuclear and Particle Physics	18 C

Learning outcome, core skills: **Learning Outcome:** By working independently within a current scientific research project students are fostered to familiarize themselves with a new advanced topic in the field of Course in Nuclear and Particle Physics. They will learn to successfully perform a sub-task and finally present the reults to a professional audience. **Core skills:** Students will be able to organize, conduct, evaluate and present small, manageable projects in the field of Nuclear and Particle Physics, obeying the rules of good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 540 h

Course: Research Lab Course in Particle Physics	
Examination: Lecture(2 weeks preparation time) (approx. 30 minutes) **Examination requirements:** Methods for in-depth familiarisation in a scientific field of work, critical review of literature, scientific presentation, good scientific practice.	18 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.409: Research Seminar Astro-/Geophysics**	4 C 2 WLH
Learning outcome, core skills: After successful completion of the module, students should present complex lines of reasoning and evaluate own and others' presentations in critical discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Research Seminar Astro-/Geophysics	
Examination: Lecture(4 weeks preparation time) (approx. 60 minutes) **Examination requirements:** Preparation of complex topics for presentation and scientific discussions.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.410: Research Seminar Biophysics/Physics of Complex Systems**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students should present complex lines of reasoning and evaluate own and others' presentations in critical discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Research Seminar Biophysics/Physics of Complex Systems	
Examination: Lecture(4 weeks preparation time) (approx. 60 minutes) **Examination prerequisites:** active partizipation **Examination requirements:** Preparation of complex topics for presentation and scientific discussions.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen Module M.Phy.411: Research Seminar Solid State/Materials Physics	4 C 2 WLH
Learning outcome, core skills: After successful completion of the module, students should present complex lines of reasoning and evaluate own and others' presentations in critical discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Research Seminar Solid State/Materials Physics	
Examination: Lecture(4 weeks preparation time) (approx. 60 minutes) **Examination prerequisites:** active participation **Examination requirements:** Preparation of complex topics for presentation and scientific discussions.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.412: Research Seminar Particle Physics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students should present complex lines of reasoning and evaluate own and others' presentations in critical discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Research Seminar Particle Physics	
Examination: Lecture(4 weeks preparation time) (approx. 60 minutes) **Examination prerequisites:** active participation **Examination requirements:** Preparation of complex topics for presentation and scientific discussions.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen Module M.Phy.413: General Seminar	4 C 2 WLH
Learning outcome, core skills: After successful completion of the module, students should be able to develop the content of scientific publications (usually in English) independently and present it to a wide audience. They should be also able to evaluate it criticaly.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: General Seminar	
Examination: Lecture(4 weeks preparation time) (approx. 60 minutes) **Examination prerequisites:** active participation **Examination requirements:** Use of presentation media, presentation of complex issues in front of expert and non-expert audiences, communication and discussion skills, critical awareness and expressiveness.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 150	

Additional notes and regulations: We recomend to chose the seminar not of the own research focus.

Georg-August-Universität Göttingen **Module M.Phy.414: Research Lab Course in Theoretical Physics**	18 C

Learning outcome, core skills: **Learning Outcome:** By working independently within a current scientific research project students are fostered to familiarize themselves with a new advanced topic in the field of Theoretical Physics. They will learn to successfully perform a sub-task and finally present the reults to a professional audience. **Core skills:** Students will be able to organize, conduct, evaluate and present small, manageable projects in the field of Theoretical Physics, obeying the rules of good scientific practice.	**Workload:** Attendance time: 0 h Self-study time: 540 h

Course: Research Lab Course in Theoretical Physics	
Examination: Lecture(2 weeks preparation time) (approx. 30 minutes) **Examination requirements:** Methods for in-depth familiarisation in a scientific field of work, critical review of literature, scientific presentation, good scientific practice.	18 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Alle Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 3 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.415: Research Seminar Theoretical Physics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the module, students are able to present complex lines of reasoning and evaluate own and others' presentations in critical discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Research Seminar Theoretical Physics	
Examination: Lecture(4 weeks preparation time) (approx. 60 minutes) **Examination prerequisites:** active participation **Examination requirements:** Preparation of complex topics for presentation and scientific discussions.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Laura Covi
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen Module M.Phy.5002: Contemporary Physics	4 C 2 WLH
Learning outcome, core skills: **Lernziele**: To understand cutting-edge research in 6 topics in physics by attending the physics colloquia. Introductory lectures will be provided to bridge the gap between students lectures and the scientific level of the colloquium. **Kompetenzen**: After successful completion of modul students should be able to... • independent learning; • independent analysis; • work in teams; • write scientific reports; • read scientifc literature; • extract the important research questions and results from the physics colloquia.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Contemporary Physics	2 WLH
Examination: written report (max. 5 pages) **Examination requirements:** Ability to combine the information given in the introductory lecture, the physics colloquium and current literature in 6 written reports on each of the colloquium topics.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Phy.5401: Advanced Statistical Physics**	6 C 6 WLH

Learning outcome, core skills: After successful completion of the module students will be familiar with the core concepts and mathematical methods of statistical physics both in and out of equilibrium. Students will be able to model and analyse interacting or fluctuation-dominated systems using methods from statistical physics, and be aware of a range of application domains including soft matter, biophysics and network dynamics.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Advanced Statistical Physics (Lecture)	4 WLH
Examination: written (120 min.) or oral exam (approx. 30 min.) **Examination prerequisites:** At least 50% of the homework of the excercises have to be solved successfully.	6 C

Course: Advanced Statistical Physics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of statistical mechanics of equilibrium
Language: English	**Person responsible for module:** Prof. Dr. Matthias Krüger
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1
Maximum number of students: 80	

Georg-August-Universität Göttingen **Module M.Phy.5403: Seminar Classical-Quantum Connections in Theoretical Physics**	4 C 2 WLH
Learning outcome, core skills: After successful completion of the module students should be familiar with core concepts and mathematical methods that find use in the study of both classical and quantum systems. Students will be able to explore specific questions with the help of book chapters or journal publications and to present the topic in a seminar talk	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar Classical-Quantum Connections in Theoretical Physics	
Examination: Oral Presentation (approx. 45 minutes) **Examination prerequisites:** regular participation **Examination requirements:** Topics will typically include: Classical & quantum path integrals, diagrammatics and perturbation theory, universality and phase transitions, effective field theories and coarse graining, quantum versus classical fluctuations theorems, quantum-classical mappings (d to d+1 dim.)	4 C

Admission requirements: none	**Recommended previous knowledge:** Advanced statistical mechanics and quantum mechanics equivalent to modules: • *Advanced Statistical Physics* • *Advanced Quantum Mechanics*
Language: English	**Person responsible for module:** Prof. Dr. Steffen Schumann
Course frequency: every 4th semester; summer term	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 2 - 4
Maximum number of students: 28	

Georg-August-Universität Göttingen **Module M.Phy.5404: Computational Quantum Many-Body Physics**	6 C 4 WLH

Learning outcome, core skills: **Lernziele**: After successful completion of the module students should be familiar with advanced computational methods for quantum many-body systems and their application to problems from condensed matter theory. **Kompetenzen**: Students are able to implement advanced computational algorithms for computational many-body physics and are familiar with the theory of the algorithms and standard applications.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Computational Many-Body Physics (Lecture)	4 WLH
Course: Computational Many-Body Physics (Exercise)	2 WLH
Examination: Oral exam (approx. 30 min.) or written exam (120 min.) and term paper (max. 5 pages)	6 C

Admission requirements: none	**Recommended previous knowledge:** basic knowledge of statistical mechanics of equilibrium and quantum mechanics, second quantization, advanced quantum mechanics
Language: English	**Person responsible for module:** Prof. Dr. Fabian Heidrich-Meisner
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.5405: Non-equilibrium Statistical Physics**	6 C 6 WLH
Learning outcome, core skills: After successful completion of the module students will be able to understand advanced methods and concepts of non-equilibrium statistical physics to current research topics. Students will be able to describe and discuss state-of-the-art issues and problems in non-equilibrium statistical physics.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: A course in the field of Non-equilibrium Statistical Physics	
Examination: Oral exam (approx. 30 min.) or written exam (120 min.) or presentation (approx. 30 min.) **Examination requirements:** Advanced topics in non-equilibrium statistical physics	6 C

Admission requirements: none	**Recommended previous knowledge:** Solid background in equilibrium and basic non-equilibrium statistical physics at the level of the module „Advanced Statistical Physics“
Language: English	**Person responsible for module:** Prof. Dr. Peter Kurt Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 80	

Georg-August-Universität Göttingen **Module M.Phy.5406: Current topics in theoretical physics**	4 C 4 WLH
Learning outcome, core skills: After successful completion of the module students will be familiar with a range of advanced concepts and methods from modern theoretical physics. Students will be able to deploy advanced methods to analyse systems and models that are of interest to current theoretical physics research, covering topics from classical to quantum and from equilibrium to non-equilibrium systems.	**Workload:** Attendance time: 56 h Self-study time: 64 h
Course: Current topics in theoretical physics (Lecture)	
Examination: oral exam (approx. 30 Min.) or written report (max. 15 p.) **Examination prerequisites:** none **Examination requirements:** At least 2 topics from 4-6 lecture blocks (to be announced at the start of the lectures) will be assessed. Topics will be taken from soft condensed matter, theor. biophysics, statistical mech., cond. matter theory, quantum many-body physics, quantum field theory, particle physics, theor. astrophysics, complex systems modelling.	4 C

Admission requirements: none	**Recommended previous knowledge:** • *Advanced Statistical Physics* • *Advanced Quantum Mechanics*
Language: English	**Person responsible for module:** Prof. Laura Covi
Course frequency: every 4th semester; summer term	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 2 - 4

Georg-August-Universität Göttingen **Module M.Phy.541: Advanced Topics in Classical Theoretical Physics I**	6 C 6 WLH

Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of Classical Theoretical Physics to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems of Classical Theoretical Physics.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: A Course (6 C) in the field of Classical Theoretical Physics *Course frequency:* each semester	
Examination: Written examination (120 Min.) or oral examination approx. 30 Min.) or talk (approx. 30 Min.),2 weeks preparation time **Examination requirements:** Advanced techniques and models in Classical Theoretical Physics	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Peter Kurt Sollich
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.542: Advanced Topics in Classical Theoretical Physics II**	6 C 4 WLH

Learning outcome, core skills: After successful completion of the modul students will be familiar with advanced concepts of Classical Theoretical Physics	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: A Course (3 C) in the field of Classical Theoretical Physics *Course frequency:* each semester	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced techniques and models in Classical Theoretical Physics	3 C

Course: A Course (3 C) in the field of Classical Theoretical Physics *Course frequency:* each semester	2 WLH

Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced techniques and models in Classical Theoretical Physics	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Peter Kurt Sollich
Course frequency: every 4th semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.543: Advanced Topics in Theoretical Quantum Physics I**	6 C 6 WLH

Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of Theoretical Quantum Physics to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems of Theoretical Quantum Physics .	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: A Course (6 C) in the field of Theoretical Quantum Physics *Course frequency:* each semester	
Examination: Written examination (120 Min.) or oral examination approx. 30 Min.) or talk (approx. 30 Min.),2 weeks preparation time **Examination requirements:** Advanced Advanced techniques and models in Theoretical Quantum Physics	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Stefan Kehrein
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.544: Advanced Topics in Theoretical Quantum Physics II**	6 C 4 WLH

Learning outcome, core skills: After successful completion of the modul students will be familiar with advanced concepts of Theoretical Quantum Physics	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: A Course (3 C) in the field of Theoretical Quantum Physics *Course frequency:* each semester	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced techniques and models in Theoretical Quantum Physics	3 C

Course: A Course (3 C) in the field of Theoretical Quantum Physics *Course frequency:* each semester	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced techniques and models in Theoretical Quantum Physics	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Prof. Dr. Steffen Schumann
Course frequency: every 4th semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.546: Seminar Advanced Topics in Theoretical Physics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of this module, students will be able to reproduce and present complex chains of arguments, assess their own and other students' presentation critically.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar Advanced Topics in Theoretical Physics	
Examination: Lecture4 weeks preparation time (approx. 60 minutes) **Examination prerequisites:** Active participation **Examination requirements:** Preparation of complex topics for presentation and scientific discussion.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5502: Numerical experiments in stellar astrophysics**	3 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should have hands-on experience in computing stellar models and solving oscillation eigenvalue problems.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Numerical experiments in stellar astrophysics (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** • Use of numerical codes to model the internal structure and oscillations of stars. • Hands-on experience with the codes. • Computation of stellar models and their oscillation frequencies. • Experimenting with parameters and physical inputs.	3 C

Admission requirements: keine	**Recommended previous knowledge:** keine
Language: English	**Person responsible for module:** Prof. Dr. Laurent Gizon
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Master: 2 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.551: Advanced Topics in Astro-/Geophysics I**	6 C 6 WLH

Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of astro- and geophysics to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems of astro-/ geophysics.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Course (6 C) in the field of Astro- or Geophysics	
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in astro- or geophysics	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.552: Advanced Topics in Astro-/Geophysics II**	6 C 4 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of astrophysics and Geophysics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Advanced Topics in Astro-/Geophysics IIa	2 WLH
Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) or talk (approx. 30 Min.), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in astro- or geophysics	3 C

Course: Advanced Topics in Astro-/Geophysics IIb	2 WLH

Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) or talk (approx. 30 Min.), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in astro- or geophysics	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik
Course frequency: each semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.556: Seminar Advanced Topics in Astro-/Geophysics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with the presentation of complext problems, scientific discussion as well as evaluation of contents of the presentations.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar Advanced Topics in Astro-/Geophysics I	
Examination: Lecture4 weeks preparation time (approx. 60 minutes) **Examination prerequisites:** active Participation **Examination requirements:** Advanced experimental techniques or theoretical models in astro- or geophysics	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Stefan Dreizler
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5601: Seminar Computational Neuroscience/Neuro-informatics**	4 C 2 WLH
Learning outcome, core skills: After successful completion of the module, students ... • have deepened their knowledge of computational neuroscience / neuroinformatics by an independent elaboration of a topic; • have learned methods of presentation of topics from computer science; • are able to deal with (English-language) literature; • are able to present an informatic topic; • are able to lead a scientific discussion.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar (Seminar) *Course frequency:* each semester	
Examination: Presentation (approx. 45 Min.) with written report (max. 7 S.) **Examination prerequisites:** regular participation **Examination requirements:** Independent preparation and presentation of research-related topics from the area of computational neuroscience / neuroinformatics as well as biophysics of neuronal systems.	4 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.5614
Language: English	**Person responsible for module:** Prof. Dr. Florentin Andreas Wörgötter
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1 - 3
Maximum number of students: 14	

Georg-August-Universität Göttingen **Module M.Phy.5604: Biomedicine imaging physics and medical physics**	6 C 4 WLH

Learning outcome, core skills: After taking this course, students will have quantitative insight into the physical, mathematical and algorithmic foundations of imaging techniques for biomedical applications, in particular CT, MRI, tomographic reconstruction, image processing, nuclear techniques, ultrasound and laser-tissue interaction up to emerging techniques such as phase contrast radiography. Further, the course leads a basic understanding of medical physics in a broader sense, including radiotherapy, radiobiology.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Vorlesung (Lecture)	
Examination: Written examination (120 Min.) or oral examination (approx. 30 Min.) or Presentation (approx. 30 Min., 2 weeks preparation time) **Examination requirements:** Knowledge of physical principles in medical diagnostics and therapy, in particular modern imaging techniques: Radiography (Absorptions- and Phase contrast), tomography, magnetic resonance imaging () positron-emissions-tomography, single photon emission tomography (SPECT), nuclear methods and probes, ultrasound imaging, optical microscopy. Along with the experimental principles, the algorithmic and mathematical concepts of image reconstruction and processing have to be mastered.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Tim Salditt
Course frequency: every 4th semester; alle 2 Jahre	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Master: 2 - 4
Maximum number of students: 50	

Georg-August-Universität Göttingen **Module M.Phy.5608: Liquid State Physics**	4 C 2 WLH
Learning outcome, core skills: Lernziele/Kompetenzen: Students should learn the core concepts of the theories and experimental phenomenology of the liquid state, from simple to macromolecular/polymeric to granular liquids. Through readings of the important papers, both seminal or at the fore-front of research, they should learn how to understand the modern open questions regarding the liquid state. Students should also explore a specific topic that is currently subject of active research, and prepare an oral presentation and a written handout at the end of the semester.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Liquid State Physics *Contents*: This course will cover the foundations of the theoretical and experimental description of simple liquids, macromolecular/polymeric liquids and granular liquids and gases. We will learn about the statistico-mechanical approach to the liquid state, including distribution function theories, Boltzmann equation and Navier-Stokes equation. We will then move on to the dynamics of macromolecular liquids such as polymers. Based on concepts like viscosity and visco-elasticity, we will also explore thin film flows and non-Newtonian phenomena. The final part of the course will consider liquids composed of “macroscopic molecules” like sand grains. While their flow behavior is often reminiscent of molecular liquids, the dissipative nature of their interaction makes them an intrinsic out of equilibrium phenomenon.	
Examination: Presentation (ca. 40 min.) and handout on special topic of choice **Examination prerequisites:** Participation in course discussion and assignments **Examination requirements:** Students will perform an in-depth investigation on a particular course topic, and present this in a symposium at the end of the course.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** StudiendekanIn der Fakultät für Physik; Ansprechpartner Dr. Marco Mazza
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Master: 1 - 4

Maximum number of students: 50	

Additional notes and regulations:

SP: Biophysik/nichtlineare Dynamik; Festkörperphysik; Materialphysik; Astrophysik; Geophysik

Georg-August-Universität Göttingen Module M.Phy.5609: Turbulence Meets Active Matter	4 C 4 WLH
Learning outcome, core skills: **Lernziele**: This course introduces elements from turbulence theory and active matter theory. In particular, we will focus on emergent behavior of active agents as well as their collective behavior in disordered environments such as turbulent flows. The essential background will be conveyed in introductory lectures. The major part of the course is dedicated to hands-on projects, in which we will address the following questions: What are the challenges in describing and predicting turbulent flows? How can simple mathematical rules give rise to large-scale order and emergent behavior? How can complex patterns emerge in non-equilibrium systems and how can we describe them mathematically? How does spatio-temporal disorder impact emergent behavior? As part of the projects, the students will set up and conduct numerical experiments in small groups. The progress of the individual projects will be discussed in weekly meetings. Finally, the students will present their findings at the end of the semester. **Kompetenzen:** The students gain an understanding of fundamental aspects of fluid mechanics and turbulence, agent-based models for collective behavior as well as elements of pattern formation. Furthermore, they acquire a basic understanding of numerical integration of partial differential equations, post-processing and statistical analysis of simulation data, and scientific visualization of simulation results.	**Workload:** Attendance time: 56 h Self-study time: 64 h
Course: Turbulence Meets Active Matter (Lecture)	2 WLH
Examination: Oral Presentation (approx. 45 minutes) **Examination prerequisites:** none **Examination requirements:** Understanding of the fundamentals taught in the fields of fluid physics and active matter, implementation of the acquired knowledge in accompanied research and programming projects, preparation of the presentation of the results and their classification in existing literature.	4 C
Course: Turbulence Meets Active Matter (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in mechanics and continuum mechanics, background in complex systems and stochastic processes
Language: English, German	**Person responsible for module:** Prof. Dr. Eberhard Bodenschatz
Course frequency: every 4th semester; Wintersemester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4

Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.Phy.561: Advanced Topics in Biophysics/Physics of complex systems I**	6 C 6 WLH
Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of Biophysics/Physics of complex systems to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems of Biophysics/ Physics of complex systems.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Course (6 C) in the field of Biophysics and Physics of Complex Systems	
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Biophysics and Physics of Complex Systems.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5610: X-ray Tomography for Students of Physics and Mathematics**	3 C 2 WLH
Learning outcome, core skills: Knowledge in: • Principles of Radiography and Tomography • Radiation Safety / Reconstruction Algorithms and practical Implementation of algorithms, testing of algorithms, cone beam reconstruction • phase retrieval and phase contrast • treatment of artefacts, filters • quantitative assessment of image quality • image segmentation Taking the course students will be able to : • operate laboratory equipment, perform tomographic alignment and to setup tomographic scans • to reconstruct data based on Matlab toolbox (Salditt Group) • to analyse data, perform segmentation	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Course: X-ray Tomography *Contents*: • one week self-study in preparation based on tutorials and the textbook by Salditt/ Aspelmeier /Aeffner (De Gruyter 2017), a full one week course with • morning lectures including Matlab tutorials • afternoon tomography practice in the laboratory using three different instruments (liquid metal jet, rotating anode, high energy), • overnight scans • Matlab-based reconstruction (Server IRP, Toolbox Salditt Group)	
Examination: Oral examination (approx. 45 minutes) **Examination requirements:** • Presentation of a successful scan and reconstruction, • oral discussion of the data and analysis	3 C

Admission requirements: none	**Recommended previous knowledge:** Electrodynamics, Matlab/Python
Language: English	**Person responsible for module:** Prof. Dr. Tim Salditt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students:	

15	

Additional notes and regulations:

1 week in October before start of lectures.

Partial overlap with Physicists’ tomography course.

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.Phy.5613: Vorlesung: Principles and Applications of Synchrotron and Free Electron Laser Radiation
English title: Lecture: Principles and Applications of Synchrotron and Free Electron Laser Radiation</td><td>3 C
4 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Lernziele:
Ziel der Lehrveranstaltung ist die enge Verknüpfung der Lehre auf dem Gebiet der Röntgenphysik mit der Arbeit an Großforschungseinrichtungen, insbesondere der Forschung im Bereich Photon Science bei DESY.
In der Vorlesung erhalten die Studierenden eine Einführung in die Forschung mit Synchrotronstrahlung und Strahlung von Freien Elektronen Lasern: Erzeugung der Strahlung und Charakteristika der Quellen, Grundlagen der Beschleunigerphysik, Experimentieraufbauten (Strahlrohre), Grundlagen der Röntgenbeugung und der Röntgenspektroskopie, Röntgenkurzzeitphysik.
Im Blockkursus erlernen sie die Anwendung röntgenphysikalischer Methoden (mit jährlich wechselnden Schwerpunkten): kohärente Abbildung, mathematische Beschreibung, Anwendungen in der Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc. (jeweils als Einführung).
Kompetenzen:
Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden...
• über fundamentales Wissen über die Prinzipien der Erzeugung von Synchrotronstrahlung und der Strahlung von Freien Elektronenlasern deren Anwendungen verfügen;
• Fähigkeiten in der mathematischen Beschreibung von Röntgenbeugung an ausgewählten, aktuellen Beispielen aus der Biophysik, Molekülphysik, Kristallographie etc. entwickelt haben.</td><td>Arbeitsaufwand:
Präsenzzeit:
88 Stunden
Selbststudium:
2 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Vorlesung (Vorlesung)
Inhalte:
Einführung in die Forschung mit Synchrotronstrahlung und Strahlung von Freien Elektronen Lasern: Erzeugung der Strahlung und Charakteristika der Quellen, Grundlagen der Beschleunigerphysik, Experimentieraufbauten (Strahlrohre), Grundlagen der Röntgenbeugung und der Röntgen-spektroskopie, Röntgenkurzzeitphysik.</td><td>SWS</td></tr>
<tr><td>Lehrveranstaltung: Blockkurs Desy Campus, Hamburg (2,5 Tage)
Inhalte:
Einführung in die Anwendungen röntgenphysikalischer Methoden (mit jährlich wechselnden Schwerpunkten) unter Anwendung hochenergetischer Strahlung: Einführung in die kohärente Abbildung, mathematische Beschreibung der Röntgenbildgebung, Anwendungen in der Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc.</td><td></td></tr>
<tr><td>Prüfung: Mündlich (ca. 45 Minuten)
Prüfungsvorleistungen:</td><td>3 C</td></tr>
</table>

Aktive Teilnahme **Prüfungsanforderungen:** Verständnis über die physikalischen Grundlagen der Forschung mit Synchrotronstrahlung und mit Strahlung von Freien Elektronen Lasern: Erzeugung der Strahlung und Charakteristika der Quellen, Grundlagen der Beschleunigerphysik, Experimentieraufbauten (Strahlrohre), Grundlagen der Röntgenbeugung, der Röntgenbildgebung und der Röntgenspektroskopie; Grundlagen der Röntgenkurzzeitphysik, Anwendung röntgenphysikalischer Methoden (mit jährlich wechselnden Schwerpunkten): kohärente Abbildung, mathematische Beschreibung, Anwendungen in der Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc. (jeweils Einführung).	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Röntgenphysik
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Simone Agnes Techert
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Master: 1 - 4
Maximale Studierendenzahl: 30	

Bemerkungen: Einbringbar in folgende Schwerpunkte: Biophysik/komplexe Systeme, Festkörper/Materialphysik

Georg-August-Universität Göttingen **Modul M.Phy.5614: Praktikum: Principles and Applications of Synchrotron and Free Electron Laser Radiation** *English title: Lab Course: Principles and Applications of Synchrotron and Free Electron Laser Radiation*	3 C 2 SWS

Lernziele/Kompetenzen: Lernziele: Ziel des Praktikums ist die enge Verknüpfung der praktisch orientierten Röntgenphysik-Hochschulausbildung mit der wissenschaftsorientierten, experimentellen Arbeit an Großforschungseinrichtungen, insbesondere der Forschung im Bereich Photon Science bei DESY. Im Blockpraktikum sollen die Studierenden ein praktisches Verständnis für komplexe Röntgenexperimente an Hochenergiestrahlungsquellen entwickeln, insbesondere an den (exemplarisch aufgelisteten) Strahlrohren P04, P08, P11, P24 des Speicherrings Petra III und der Strahlrohre PES und CAMP des Freien Elektronenlasers FLASH und FLASH II. Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden... • experimentelle Fähigkeiten und Basiswissen in Röntgenexperimenten entwickelt haben an ausgewählten, wissenschaftlich aktuellen Beispielen aus der Biophysik, Molekülphysik, Kristallographie etc., • grundlegende experimentelle Expertise in Röntgenexperimenten an Hochenergiestrahlungsquellen erworben haben, u.a. auf dem Gebieten der Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc.	**Arbeitsaufwand:** Präsenzzeit: 88 Stunden Selbststudium: 2 Stunden

Lehrveranstaltung: Einwöchiges Blockpraktikum am Desy *Inhalte*: Inhalte: Erlangung von experimentellen Fähigkeiten und Expertise von komplexen Röntgenexperimenten mit Hochenergiestrahlungsquellen; tieferes Verständnis von Röntgensynchrotron-Strahlungs-Experimente exemplarisch an Experimenten der Strahlrohre P04, P08, P11 oder P24 des Speicherrings Petra III und der Strahlrohre PES und CAMP des Freien Elektronenlasers FLASH oder FLASH II (wechselnde Schwerpunkte); Einführung in die Praxis röntgenphysikalischer: kohärente Abbildung, mathematische Beschreibung, Anwendungen in der Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc.	2 SWS
Prüfung: Mündlich (ca. 45 Minuten) **Prüfungsvorleistungen:** Aktive Teilnahme **Prüfungsanforderungen:** Vorliegendes Protokoll zum Blockpraktikum mit eigenständig erarbeitetem Auswerteinhalt (Einführungsniveau). Grundlegende Kenntnisse zu Experimenten mit Synchrotronstrahlung und Strahlung von Freien Elektronen Lasern. Exemplarisch: Grundlegendes Verständnis an aktueller	3 C

Beispiele von Röntgenexperimenten aus den Gebieten der Biophysik, Molekülphysik, Biophysik, Molekülphysik, Kristallographie, Kurzzeitphysik, etc. (je nach Praktikumort an P04, P08, P11 oder P24 des Speicherrings Petra III und der Strahlrohre PES und CAMP des Freien Elektronenlasers FLASH oder FLASH II). Nachweis experimenteller Fähigkeiten, Nachweis von mathematische Expertise (weitreichendere Grundlagen) zur Auswertung von Röntgenexperimenten, Reflektion der durchgeführten Experimente.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Einführung in die Röntgenphysik
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Simone Agnes Techert
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Master: 1 - 4
Maximale Studierendenzahl: 10	

Bemerkungen: Einbringbar in folgende Schwerpunkte: Biophysik/komplexe Systeme, Festkörper/Materialphysik

Georg-August-Universität Göttingen **Module M.Phy.562: Advanced Topics in Biophysics/Physics of complex systems II**	6 C 4 WLH
Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of Biophysics and Physics of Complex Systems.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Course (3 C) in the Field of Biophysics/Physics of complex systems	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Biophysics and Physics of Complex Systems	3 C
Course: Course (3 C) in the Field of Biophysics/Physics of complex systems	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Biophysics and Physics of Complex Systems	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.566: Seminar Advanced Topics in Biophysics/ Complex Systems**	4 C 2 WLH
Learning outcome, core skills: After successful completion of the modul students should be familiar with the presentation of complext problems, scientific discussion as well as evaluation of contents of the presentations.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar Advanced Topics in Biophysics/Complex Systems	
Examination: Lecture4 weeks preparation time (approx. 60 minutes) **Examination prerequisites:** active Participation **Examination requirements:** Advanced experimental techniques or theoretical models in astro- or geophysics	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen Module M.Phy.5701: Advanced Solid State Theory	6 C 6 WLH
Learning outcome, core skills: After successful completion of the modul students should be able to perform calculations using many-body techniques, describe and model simple experimental observations, understand and use the language of modern solid-state theory.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Lecture	4 WLH
Examination: written exam (90 min.) or oral exam (approx. 30 min.) **Examination requirements:** Quantum-field theoretical description of solids, elements of ab initio methods, symmetries and binding, optical properties of solids, correlated electron systems, elements of transport theory. Formulation of theories based on experimental observation, description and interpretation of experiments in solids, knowledge of manybody techniques	6 C
Course: Exercises	2 WLH

Admission requirements: none	**Recommended previous knowledge:** Introduction to Solid State Physics Quantum mechanics I
Language: English	**Person responsible for module:** Dean of Studies, Faculty of Physics
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Master: 2 - 3
Maximum number of students: 40	

Georg-August-Universität Göttingen **Modul M.Phy.5703: Materialforschung mit Elektronen** *English title: Materials research with electrons*	6 C 4 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden elektronenoptischen und spektroskopischen Methoden kennen und in der Auswertung von Untersuchungsergebnissen anwenden können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vorlesung mit Seminar	
Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Mündlich (ca. 30 Minuten)	6 C
Prüfung: Vortrag (ca. 60 Minuten) **Prüfungsvorleistungen:** Aktive Teilnahme im Seminar	6 C
Prüfungsanforderungen: Kenntnisse grundlegender elektronenoptischer und –spektroskopischer Methoden und ihrer praktischen Anwendung auf materialphysikalische Fragestellungen Grundlagen der Transmissionselektronenmikroskopie, Wechselwirkung von Elektronen mit Materialien, Elektronenbeugung, Hochauflösung, Rastertransmissionselektronenmikroskopie Analytische Methoden wie EDX und EELS, In-situ Verfahren, Dynamische und ultraschnelle Elektronenmikroskopie.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Quantenmechanik I Einführung in die Materialphysik Einführung in die Festkörperphysik
Sprache: Deutsch	**Modulverantwortliche[r]:** StudiendekanIn der Fakultät für Physik
Angebotshäufigkeit: 2jährig (SoSe)	**Dauer:** 1 Semester
Wiederholbarkeit: dreimalig	**Empfohlenes Fachsemester:** Master: 1 - 3
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Module M.Phy.5705: Materials Physics I: Microstructure-Property-Relations**	4 C 3 WLH

Learning outcome, core skills: AAfter successful completion of this Module, the student will have obtained an overview about the realistic structure of materials (realistic = including defects and irregularities). Inaddition, a deepened understanding of the relation between micro-structure andfundamental material properties will have been gained via the discussion of theoreticalmodels and experimental results.	**Workload:** Attendance time: 42 h Self-study time: 78 h

Course: Materials Physics I: Microstructure-Property-Relations *Contents*: Basic concepts of structure-property relations and defects, topology,thermodynamics and properties of defects, microstructure and mechanical properties.	
Examination: Presentation (approximately 30 minutes) or written examination (120 minutes) or oral examination (approximately 30 minutes) **Examination prerequisites:** At least 50% of the homework problems need to be solved correctly. **Examination requirements:** Global and local symmetries in materials, elastic continuum theory, structure of pointdefects, dislocations and grain boundaries, thermodynamics of defects, mechanical /chemical / electronic / transport properties of defects, as well as methods for the investigation of micro-structure and related properties.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introductory courses in materials science and solid state physics.
Language: English	**Person responsible for module:** Prof.in Cynthia Ann Volkert
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 3
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.Phy.5706: Materials Physics II: Kinetics and Phase Transformations**	4 C 3 WLH
Learning outcome, core skills: After successful completion of this Module, the student will have obtained an overview of theoretical concepts and mechanisms of phase transformations in materials. In addition, a deeper understanding of the description of kinetic processes in the framework of irreversible thermodynamics will have been gained.	**Workload:** Attendance time: 42 h Self-study time: 78 h
Course: Materials Physics II: Kinetics and Phase Transformations *Contents*: Fundamentals and specific examples of the behavior of condensed mattersystems in non-equilibrium situations.	
Examination: Presentation (approximately 30 minutes) or written exam (120 minutes) or oral examination (approximately 30 minutes) **Examination prerequisites:** At least 50% of the homework problems need to be solved correctly. **Examination requirements:** Non-equilibrium thermodynamics, generalized driving forces, diffusion, nucleation, motion and instabilities of interfaces, solidification, precipitation, domain growth, spinodal decomposition, order-disorder phase transitions, kinetically controlled transformations.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introductory courses in materials science and solid state physics, as well as the course Materials Physics I.
Language: English	**Person responsible for module:** Prof.in Cynthia Ann Volkert
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 2 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen Module M.Phy.5707: Materials research with electrons	3 C 2 WLH
Learning outcome, core skills: Fundamentals of the application of electron microscopy to the characterization and analysis of materials, with emphasis on: • Interactions between electrons and solids • Preparation of samples, limits of electron microscopy • Fundamentals and advanced concepts of electron microscopy • Diffraction and imaging • Analytical applications (EDX, EELS, GPA, …) • Overview of current research topics After successful completion of this Module, the student will be able to understand further developments of electron microscopy and gain access to current research themes.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Materials research with electrons (Lecture)	
Examination: Oral examination(approximately 30 minutes) **Examination requirements:** Understanding of fundamental concepts, facts, and methods. Basic understanding of diffraction, imaging, and analysis.	3 C

Admission requirements: none	**Recommended previous knowledge:** Introductory courses in materials science and solid state physics.
Language: English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt
Course frequency: Every 2 years, summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.5708: Physics of Semiconductor Devices**	4 C 2 WLH

Learning outcome, core skills: After successful completion of this module the students will be able to understand basic and advanced concepts of the physics of electronic and opto-electronic semiconductor devices.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Physics of Semiconductor Devices (Lecture with seminar)	2 WLH
Examination: Oral examination (approx. 45 minutes) **Examination prerequisites:** active participation in seminar **Examination requirements:** Basic and advanced concepts of the physics of semiconductors and their devices.	4 C

Admission requirements: none	**Recommended previous knowledge:** Einführung in die Festkörperphysik, Solid State Physics II
Language: English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 3
Maximum number of students: 20	

Georg-August-Universität Göttingen Module M.Phy.5709: Physics of Semiconductors	3 C 2 WLH
Learning outcome, core skills: After successful completion of this module the students will be able to understand basic and advanced concepts of the physics of semiconductors and their devices with emphasis on: • **electronic transport** • **doping** • **electronic states** • **optical properties** • **semiconductor junctions** • **nanostructures**	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Physics of Semiconductors (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Basic and advanced concepts of the physics of semiconductors.	3 C

Admission requirements: none	**Recommended previous knowledge:** Einführung in die Festkörperphysik, Solid State Physics II
Language: English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.571: Advanced Topics in Solid State/Materials Physics I**	6 C 6 WLH

Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of Solid State/Materials Physics to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems of Solid State/ Materials Physics.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: A course (6 C) in the field of Solid State/Materials Physics	
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Solid State/Materials Physics	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Master: 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5710: Physics of Semiconductors and Semiconductor Devices**	6 C 4 WLH

Learning outcome, core skills: After successful completion of this module the students will be able to understand basic and advanced concepts of the physics of semiconductors and their devices with emphasis on: • electronic transport • doping • electronic states • optical properties • semiconductor junctions • nanostructures • physics of electronic and opto-electronic devices	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Physics of Semiconductors and Semiconductor Devices (Lecture with seminar) (Lecture, Seminar)	4 WLH
Examination: Presentation (approx. 60 min.) or oral examination (approx. 30 min.) **Examination prerequisites:** regular attendance in seminar **Examination requirements:** Basic and advanced concepts of the physics of semiconductors and their devices.	6 C

Admission requirements: none	**Recommended previous knowledge:** Einführung in die Festkörperphysik, Solid State Physics II
Language: English	**Person responsible for module:** apl. Prof. Dr. Michael Seibt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen Module M.Phy.5711: Surface Physics	3 C 2 WLH

Learning outcome, core skills: **Learning outcome:** After having successfully completed the module students should understand the fundamental concepts of the rapidly evolving field of surface physics. They should be able to transfer this knowledge to other areas like the physics of nanostructures and interfaces. More specifically, the students will have basic knowledge in the following topics: 1. Geometry of surfaces (e.g. relaxation, reconstruction, Wood's notation) 2. Electronic states of surfaces (e.g. surface states, projected band structure) 3. Processes at surfaces (e.g. adsorption, growth, diffusion) 4. Preparation and analysis of surfaces (e.g. UHV techniques, STM, LEED, PES) 5. Surface Excitations (e.g. surface phonons, surface plasmons) 6. Interfaces, Nanostructures **Core skills:** The students will have a fundamental understanding of the general structural and electronic properties of solid state surfaces. They will have a basic knowledge of current surface preparation and surface analysis methods.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Surface Physics (Lecture)	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Basic knowledge and understanding of surface physics, i.e. atomic and electronic structure of solid surfaces including concepts like e.g. reconstruction, surface states, surface phonons, adsorption, experimental methods.	3 C

Admission requirements: none	**Recommended previous knowledge:** B.Phy.1521: Introduction to Solid State Physics
Language: English, German	**Person responsible for module:** Prof. Dr. Martin Wenderoth
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.5712: Topology in Condensed Matter Physics**	6 C 6 WLH

Learning outcome, core skills: After a successful completion of the course, the students will be familiar with the basic concepts and properties of topological states of matter in condensed matter physics and representative examples.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Topology in Condensed Matter Physics (Lecture)	4 WLH
Examination: Written or oral examWritten exam (120 min.) or oral exam (ca. 30 min.) - determination of exam type: see UniVZ **Examination requirements:** Basic concepts of topological states of matter in condensed matter physics and knowledge and understanding of representative examples.	6 C

Course: Topology in Condensed Matter Physics (Exercise)	2 WLH

Admission requirements: none	**Recommended previous knowledge:** • Solid State Physics, • Introduction to Solid State Theory, • Quantum mechanics I
Language: English	**Person responsible for module:** Prof. Dr. Fabian Heidrich-Meisner
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.572: Advanced Topics in Solid State/Materials Physics II**	6 C 4 WLH
Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of Solid State/Materials Physics.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Course (3 C) in the field of Solid State/Materials Physics	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Solid State/Materials Physics	3 C
Course: Course (3 C) in the field of Solid State/Materials Physics	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Solid State/Materials Physics	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.576: Seminar Advanced Topics in Solid State/ Materials Physics**	4 C 2 WLH
Learning outcome, core skills: After successful completion of the modul students should be familiar with the presentation of complext problems, scientific discussion as well as evaluation of contents of the presentations.	**Workload:** Attendance time: 28 h Self-study time: 92 h
Course: Seminar Advanced Topics in Solid State/Materials Physics	
Examination: Lecture4 weeks preparation time (approx. 60 minutes) **Examination prerequisites:** active participation **Examination requirements:** Advanced experimental techniques or theoretical models in Solid State/Materials Physics	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5801: Detectors for particle physics and imaging**	3 C 3 WLH

Learning outcome, core skills: After successful completion of this module, students should bfamiliar with modern methods and questions about detector physics in high energy physics, imaging and related fields.	**Workload:** Attendance time: 42 h Self-study time: 48 h

Course: Detectors for particle physics and imaging	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Based on the introductory lecture "interactions between radiation and matter" this lecture covers special topics of detector physics such as the layout of certain detector types (i.e. semiconductor detectors, ionisation detectors etc.), readout systems and noise contribution, radiation damage of detector material and readout as well as the application of such detectors.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: every 4th semester; irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Master: 1 - 3
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Phy.5804: Simulation methods for theoretical particle physics**	3 C 3 WLH
Learning outcome, core skills: The aim of the lecture is to convey the theoretical foundations of simulations of particle-physics scattering experiments. While the relevant theoretical concepts get introduced and discussed in the lectures, the tutorials provide hands-on experience with corresponding computer codes. The successful participation in the module the students will have experience with the tools and methods used in high-energy particle physics research. They will be in a position to carry out corresponding calculations and understand contemporary research subjects	**Workload:** Attendance time: 42 h Self-study time: 48 h
Course: Tutorial Simulation methods for theoretical particle physics	1 WLH
Course: Lecture Simulation methods for theoretical particle physics (Lecture)	2 WLH
Examination: Written exam (30 Min.) or oral exam (approx. 30 Min.) **Examination requirements:** Solid understanding of the foundations of the theoretical description of high-energy scattering experiments. Ability to carry out corresponding calculations and simulations.	3 C

Admission requirements: keine	**Recommended previous knowledge:** Quantum mechanics II, Quantum Field Theory
Language: English	**Person responsible for module:** Prof. Dr. Steffen Schumann
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Master: 1 - 4
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Phy.5807: Particle Physics III - of and with leptons**	6 C 6 WLH
Learning outcome, core skills: After successful completion of this module, students should be familiar with the properties and interactions of leptons as well as with experimental methods and experiments which lead to their discovery and are used for precise studies.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Lecture and exercises - Particle Physics III	
Examination: Oral examination (approx. 45 minutes) **Examination requirements:** Discovery of leptons, properties of leptons, weak interactions and V-A structure, neutral currents, standard model of particle physics, e+e- physics at LEP, fermion pair production at varying center of mass energy, lineshape of cross-section at Z-pole, number of light neutrino generations, forward-backward-asymmetry, tau-polarisation, e+e- physics at the LHC, (g-2)_myon, neutrinos and neutrino oscillations, solar neutrinos, atmospheric neutrinos, long-baseline experiments, neutrino factories, neutrino mass, neutrinoless double-beta decay.	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Nuclear/Particle Physics
Language: German, English	**Person responsible for module:** Prof. Dr. Arnulf Quadt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** Master: 1 - 3
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Module M.Phy.581: Advanced Topics in Nuclear and Particle Physics I**	6 C 6 WLH

Learning outcome, core skills: **Learning outcome:** After successful completion of the modul students will be able to understand and apply advanced concepts of Nuclear and Particle Physics to current research topics. **Core skills:** Students will be able to describe and discuss state-of-the-art problems of Nuclear and Particle Physics.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: A Course (6 C) in the field of Nuclear and Particle Physics	
Examination: Written examination (120 Min.) or oral examination approx. 30 Min.) or talk (approx. 30 Min.),2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Nuclear and Particle Physics	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5810: Physics and Applications of Ion solid interaction**	6 C 6 WLH

Learning outcome, core skills: After successful completion of the module students should be familiar with theoretical background and advanced concepts of ion solid interaction, electronic and nuclear energy loss, thermal spikes, ion sputtering, ion beam analysis techniques, ion implantation, ion accelerators and ion sources, simulation of ion solid interaction, ion induced surface pattern formation, ion microscopy and focused ion beam techniques.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Physics and Applications of Ion solid interaction in the field of Solid State/Materials Physics (Lecture)	4 WLH
Course: Practical lab excercises Physics and Applications of Ion solid interaction in the field of Solid State/Materials Physics	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Advanced experimental techniques and theoretical models in ion-solid interaction	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to solid state physics
Language: English, German	**Person responsible for module:** Prof. Dr. Hans Christian Hofsäss
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.5811: Nuclear Solid State Physics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of the module students should be familiar with the physics of hyperfine interactions and interaction of nuclear moments with external magnetic and electric fields, Mössbauer spectroscopy and perturbed angular correlation of gamma radiation, nuclear magnetic resonance techniques, myon spin rotation, positron annihilation spectroscopy, neutron scattering and electron emission channeling.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Nuclear solid state physics in the field of Nuclear and Particle Physics and/or Solid State and Materials Physics (Lecture)	4 WLH
Course: Exercises in the field of Nuclear and Particle Physics and/or Solid State and Materials Physics (Exercise)	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Nuclear solid state physics concepts and techniques, physics of hyper fine interactions, interaction of neutrons with matter, physics of nuclear resonance techniques, application of positrons, myons and decay electrons to materials characterization.	4 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to nuclear and particle physics Introduction to solid state physics
Language: English, German	**Person responsible for module:** Prof. Dr. Hans Christian Hofsäss
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Phy.582: Advanced Topics in Nuclear and Particle Physics II**	6 C 4 WLH

Learning outcome, core skills: After successful completion of the modul students should be familiar with advanced concepts of Nuclear and Particle Physics	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: A Course (3 C) in the field of Nuclear and Particle Physics	2 WLH
Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Nuclear and Particle Physics	3 C

Course: A Course (3 C) in the field of Nuclear and Particle Physics	2 WLH

Examination: Written exam (120 min) or oral exam (ca. 30 min) or talk (ca. 30 min), 2 weeks preparation time **Examination requirements:** Advanced experimental techniques or theoretical models in Nuclear and Particle Physics	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.586: Seminar Advanced Topics in Nuclear and Particle Physics**	4 C 2 WLH

Learning outcome, core skills: After successful completion of this module, students should be able to reproduce and present complex chains of arguments, assess their own and other students' presentation critically.	**Workload:** Attendance time: 28 h Self-study time: 92 h

Course: Seminar Advanced Topics in Nuclear and Particle Physics	
Examination: Lecture4 weeks preparation time (approx. 60 minutes) **Examination prerequisites:** Active participation **Examination requirements:** Preparation of complex topics for presentation and scientific discussion.	4 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Module M.Phy.603: Writing scientific articles**	6 C 2 WLH

Learning outcome, core skills: **Objective:** Basics of writing a scientific paper, form and and content of a Scientific paper, correspondence with scientific journals, understanding and imparting of content of current research, scientific discussion with co - authors **Competences:** After successfully completing the module students should know how to... • write a scientific article • submit a publication in the respective field • impart their independently developed effort	**Workload:** Attendance time: 28 h Self-study time: 152 h

Course: Workshop	1 WLH
Course: Accompanying Seminar	1 WLH
Examination: written report (max. 20 S.), not graded **Examination prerequisites:** active participation	6 C

Examination requirements: a) Writing scientific articles b) Submit sciientific publications	

Admission requirements: The Bachelor Thesis has to... • meet high academic standards • be a scientific progress in the science • be an independent performance The determination of the access authorization is performed by the module responsible. She/He may request the opinion of an authorized examinator in the related field.	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dean of Studies of the Faculty of Physics
Course frequency: each semester; nach Bedarf	**Duration:** 2 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 4
Maximum number of students: not limited	

Fakultät für Agrarwissenschaften:

Nach dem Beschluss des Fakultätsrats der Fakultät für Agrarwissenschaften vom 21.12.2023 hat das Präsidium der Georg-August-Universität Göttingen am 31.01.2024 die Neufassung des Modulverzeichnisses zur Prüfungs- und Studienordnung für den Bachelor-Studiengang „Agrarwissenschaften“ genehmigt (§ 44 Abs. 1 Satz 2 NHG, §§ 37 Abs. 1 Satz 3 Nr. 5 b), 44 Abs. 1 Satz 3 NHG).

Georg-August-Universität
Göttingen

Modulverzeichnis

zu der Prüfungs- und Studienordnung für den Bachelor-Studiengang "Agrarwissenschaften" (Amtliche Mitteilungen I Nr. 36/2022 S. 676, zuletzt geändert durch Amtliche Mitteilungen I Nr. 30/2023 S. 1127)

Module

Übersicht nach Modulgruppen

I. Bachelor-Studiengang Agrarwissenschaften

Es müssen Leistungen im Umfang von insgesamt wenigstens 180 C erfolgreich absolviert werden.

1. Fachwissenschaft

a. Pflichtmodule

Es müssen folgende 15 Pflichtmodule im Umfang von insgesamt 90 C erfolgreich absolviert werden.

2. Studienschwerpunkte

Es muss ein Studienschwerpunkt im Umfang von insgesamt wenigstens 60 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden. 12 C werden dem Professionalisierungsbereich zugerechnet.

a. Studienschwerpunkt "Agribusiness"

aa. Block A

Es müssen folgende fünf Wahlpflichtmodule im Umfang von insgesamt 30 C erfolgreich absolviert werden:

bb. Block B

Es müssen 3 der folgenden Wahlpflichtmodule im Umfang von insgesamt wenigstens 18 C erfolgreich absolviert werden.

cc. Block C

Es müssen folgende Module im Umfang von insgesamt 12 C erfolgreich absolviert werden.

c. Studienschwerpunkt "Nutztierwissenschaften"

aa. Block A

Es müssen die fünf folgenden Wahlpflichtmodule im Umfang von insgesamt 30 C erfolgreich absolviert werden:

bb. Block B

Es müssen 3 der folgenden Wahlpflichtmodule im Umfang von insgesamt wenigstens 18 C erfolgreich absolviert werden.

cc. Block C

Es müssen folgende Module im Umfang von insgesamt 12 C erfolgreich absolviert werden.

d. Studienschwerpunkt "Ressourcenmanagement"

aa. Block A

Es müssen die vier folgenden Wahlpflichtmodule im Umfang von insgesamt 24 C erfolgreich absolviert werden: B.Agr.0316; B.Agr.0323; B.Agr.0328 und B.Agr.0402. Darüber hinaus muss entweder das Modul B.Agr.0389 oder das Modul B.Agr.0398 erfolgreich absolviert werden. Es kann nur ein Modul von den beiden Modulen B.Agr.0389 und B.Agr.0398 belegt werden.

bb. Block B

Es müssen 3 der folgenden Wahlpflichtmodule im Umfang von insgesamt wenigstens 18 C erfolgreich absolviert werden. Es kann nur ein Modul von den beiden Modulen B.Agr.0389 und B.Agr.0398 belegt werden, welches zuvor nicht in Block A eingebracht wurde.

cc. Block C

Es müssen folgende Module im Umfang von insgesamt 12 C nach Maßgabe der folgenden Bestimmung erfolgreich absolviert werden.

i. C1

Es muss eines der folgenden Module im Umfang von 6C erfolgreich absolviert werden:

ii. C2

Es muss eines der folgenden Module im Umfang von 6 C erfolgreich absolviert werden:

e. Studienschwerpunkt "Wirtschafts- und Sozialwissenschaften des Landbaus"

aa. Block A

Es müssen die fünf folgenden Wahlpflichtmodule im Umfang von insgesamt 30 C erfolgreich absolviert werden:

bb. Block B

Es müssen 3 der folgenden Wahlpflichtmodule im Umfang von insgesamt wenigstens 18 C erfolgreich absolviert werden.

cc. Block C

Es müssen folgende Module im Umfang von insgesamt 12 C erfolgreich absolviert werden.

3. Fachwissenschaftliche Wahlpflichtmodule, Block D

Es müssen weitere Module im Umfang von insgesamt 18 C aus dem Gesamtangebot der Studienschwerpunkte erfolgreich absolviert werden. Die Module können auch auf Antrag aus verwandten Bachelor-Studiengängen anderer Fakultäten eingebracht werden, sofern die Modulwahl eine sinnvolle Ergänzung zu dem Bachelorstudium darstellt. Eine ergänzende Auswahl an möglichen Modulen findet sich im Vorlesungsverzeichnis (eCampus/EXA) unter "optionale Block–D Veranstaltungen". Alternativ können Module aus dem Angebot der Zentralen Einrichtung für Sprachen und Schlüsselqualifikationen (ZESS) oder des universitätsweiten Modulverzeichnisses Schlüssel-kompetenzen im Umfang von insgesamt bis zu 6 C berücksichtigt werden. 6 C werden dem Professionalisierungsbereich zugerechnet

4. Bachelorarbeit

Durch die erfolgreiche Anfertigung der Bachelorarbeit werden 12 C erworben.

II. Agrarwissenschaften als Kompetenzbereich im Umfang von 42 C in einem anderen Bachelor-Studiengang

Im Modulpaket (außersoziologischer/außerethnologischer Kompetenzbereich) im Studiengebiet "Agrarwissenschaften" sind insgesamt mindestens 42 C nach Maßgabe der folgenden Bestimmungen zu erwerben:

1. Bereich A

Es müssen folgende 3 Module im Umfang von insgesamt 18 C erfolgreich absolviert werden:

2. Bereich B

Es müssen folgende 4 Module im Umfang von insgesamt 24 C erfolgreich absolviert werden:

Georg-August-Universität Göttingen **Modul B.Agr.0001: Agrarökologie und Umweltpolitik** *English title: Agroecology and Environmental Politics*	6 C 4 SWS
Lernziele/Kompetenzen: Teilmodul 1: Grundlagen der Agrarökologie: Verstehen und Anwendung grundsätzlicher Methoden der Analyse und Bewertung von Ökosystemen; Aufstellen einfacher Populationswachstumsgleichungen, Phasendiagramme, einfache Differenzialgleichungen; Erkennen der Organisationsebenen in belebten Systemen, Verstehen von räumlichen und zeitlichen Dimensionen. Auseinandersetzung mit aktuellen Problemen der Ökologie anthropogen genutzter Systeme. Gesamtverständnis von Ökologie als Wissenschaft und deren Vernetzung unter ökonomischen und politischen Rahmenbedingungen. Teilmodul 2: Grundlagen der Umweltpolitik Verstehen und Anwendung der ökonomischen Methodik im Rahmen von ausgewählten Analysen des Umwelt- und Ressourcenschutzes; Verstehen und Anwenden der institutionenökonomischen Analyse; Erkennen der Bedeutung von institutionellen Strukturen für Agrar- und Umweltentwicklungen. (Weiter-)Entwicklung des Gesamtverständnisses der Interaktion gesellschaftlicher und natürlicher Prozesse.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Grundlagen der Agrarökologie (Vorlesung) *Inhalte*: Einführung in die Ökologie (Autökologie, Demökologie, Synökologie, Evolution, Biodiversität, Ökosysteme) mit Beispielen aus Agrarökosystemen; Charakteristika der Agrarökosysteme, Lebensraumbewertung, Standortabhängigkeit bodenbildender Faktoren und Bodenfunktionen, Bodenökologie Naturschutzperspektiven für die Agrarlandschaft, Agrarökonomie und Agrarökologie, Globale Umweltveränderungen und Internationale Agrarpolitik	2 SWS
Prüfung: Klausur (45 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse der Ökologie und wichtiger Begriffsdefinitionen, Spezielle Charakteristika der Agrarökosysteme; Grundlagen der Evolution, Phylogenetik und Biodiversität; Grundkenntnisse zu Naturschutzperspektiven in der Agrarlanschaft;Fähigkeit, das erlernte Wissen problemlösend anzuwenden.	3 C
Lehrveranstaltung: Grundlagen der Umweltpolitik (Vorlesung) *Inhalte*: Einführung in die Institutionen-, Umwelt- und Ressourcenökonomik mit Beispielen aus der Agrar- und Umweltpolitik in Europa und Deutschland.	2 SWS
Prüfung: Klausur (45 Minuten) **Prüfungsanforderungen:**	3 C

Einführende und grundlegende Kentnisse der Institutionen, Umwelt- und Ressourcenökonomie, inkl. deren Anwendung im europäischen und deutschen Agrar- und Umweltschutzmodell.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Teilmodul 1: Prof. Dr. Catrin Westphal; Teilmodul 2: Dr. Holger Bergmann
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** ab 1
Maximale Studierendenzahl: 250	

Georg-August-Universität Göttingen **Modul B.Agr.0002: Biologie der Pflanzen** *English title: Botany*	6 C 4 SWS

Lernziele/Kompetenzen: Studierende erlernen die Grundlagen der Biologie tätigkeitsbezogen im Umfeld der Agrarwissenschaften anzuwenden. Sie sind in der Lage mit ihren Kenntnissen selbständige Problemlösungen auf Grundlage der vermittelten naturwissenschaftlichen Grundlagen zu erarbeiten. Sie können mit dem Erlernten relevante Informationen bewerten und wissenschaftlich fundierte Urteile ableiten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Biologie der Pflanze (Vorlesung) *Inhalte*: • Zellbiologie (Prof. Scholten): Molekularer Aufbau des pflanzlichen Organs (Kohlenstoff, Makromoleküle, Proteine, Nucleinsäuren, Polysacharide); Struktureller Aufbau des Protoplasmas (Grundstruktur, Biomembranen, Cytoskelett); Zelle (Cytoplasma, Mitochondrien, Plastiden, Zellkern). • Anatomie und Morphologie (Dr. Sirrenberg): Systematik und Taxonomie, Differenzierung der Zelle (Gewebetypen, Zellinhaltsstoffe, Zellwandwachstum, Verholzung), Bau der Sprossachse, sekundäres Dickenwachstum, Metamorphosen der Sprossachse, Bau des Blattes, Differenzierungen der Wurzel, Blüte und Fruchtknoten, Fruchtformen • Physiologie (Dr. Naumann): Energieumwandlung, Syntheseleistungen und Dissimilation autotropher Pflanzen (Biokatalyse, Photosynthese, Chemosynthese, Dissimilation von Kohlenhydraten und Fetten); Haushalt von Stickstoff, Schwefel und Phosphor • Nutzpflanzen (Prof. Siebert): Herkunft von Nutzpflanzen, weltweiter Anbau, Ertragsorgane und deren Nutzung, Ökonomie und Ökologie • Fortpflanzung und Entwicklung (Prof. Scholten): Fortpflanzung (vegetative Fortpflanzung, sexuelle Fortpflanzung, Generationswechsel); Vererbung (Replikation der DNA, Mutationen, Evolution); Wachstum und Entwicklung (Steuerung der Organentwicklung, Einfluss äußerer Faktoren); Molekulare Genetik (Biotechnologie, Genetik und Epigenetik, Genexpression und -regulation)	4 SWS
Prüfung: Klausur (60 Minuten) **Prüfungsanforderungen:** Kenntnisse in den Grundlagen der Zellbiologie, Anatomie, Morphologie, Physiologie, Molekularbiologie, Entwicklungsbiologie und Taxonomie der Pflanzen	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Stefan Scholten

Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** ab 1
Maximale Studierendenzahl: 400	

Georg-August-Universität Göttingen **Modul B.Agr.0003: Biologie der Tiere** *English title: Introduction to zoology, anatomy and physiology*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erwerben in diesem Modul instrumentale, systematische und kommunikative Kompetenzen in den Bereichen Zytologie, Histologie, klassische und molekulare Genetik, Anatomie und Physiologie der Haustiere. Im Bereich der Anatomie und Physiologie werden Schwerpunkte in den für die Agrarwissenschaften relevanten Organsystemen gelegt.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Biologie der Tiere (Vorlesung) *Inhalte*: Zytologie, Histologie, Mendelsche Genetik, Herz-Kreislaufsystem, Atmungssystem, Verdauungssystem mit seinen Organen (Leber, Pancreas), Geschlechtsorgane, Reproduktion und hormonelle Regulation, harnbildende- und harnleitende Organe, Skelettsystem und Muskulatur, Sinnesphysiologie, Nervensystem.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse der Zytologie, Histologie, der Mendelschen Genetik, des Herz-Kreislaufsystem, von Atmungssystem, Verdauungssystem mit seinen Organen (Leber, Pancreas), Geschlechtsorgane, Reproduktion und hormonelle Regulation, harnbildende- und harnleitende Organe, Sekelettsystem und Muskulatur, Sinnesphysiologie, Nervensystem.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Dr. Bertram Brenig
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 400	

Georg-August-Universität Göttingen **Modul B.Agr.0004: Bodenkunde und Geoökologie** *English title: Soil Science and Geoecology*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben Kenntnisse der bodenkundlichen Grundlagen als Basis von agrarischen Produktions- und Ökosystemen. Sie können die wichtigsten bodengenetischen Prozesse der mitteleuropäischen Böden einordnen und die Bedeutung der Steuerung der Stoffkreisläufe N-P-K über den Boden einschätzen. Zusammen mit der Befähigung die Klassifikationssysteme und die Prinzipien der Bodenschätzungslehre anwenden zu können, sind sie in der Lage relevante Informationen zu interpretieren, um wissenschaftlich fundierte Urteile abzuleiten. Die Studierenden können ihr Wissen auf ihre berufliche Tätigkeit anwenden und sind in der Lage sich selbständig mit weiterführenden Fragen der Bodenkunde auseinanderzusetzen.	**Arbeitsaufwand:** Präsenzzeit: 66 Stunden Selbststudium: 114 Stunden
Lehrveranstaltung: Bodenkunde und Geoökologie (Vorlesung, Übung) *Inhalte*: Nach Darlegen der fundamentalen bodenkundlichen Grundlagen in den Teilgebieten: • Bodenphysik, -hydrologie, -gefüge • Bodenbiologie, -humus • Bodenchemie und Mineralogie • Bodenentwicklung und -verbreitung • Bodennomenklatur, -systematik, -taxanomie • Böden als Element agrarischer Ökosysteme wird zu den praktischen Fragestellungen des Bodenschutzes in der Landwirtschaft und der Gesellschaft Stellung bezogen.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Einführende Kenntnisse der Gesteine u. Minerale, des Wasserhaushalts, von Humus, Stoffumsetzungen im System Boden, Bodenentstehung, Bodentypen, Bodentaxonomie und Bodenschutz.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Peter Gernandt
Angebotshäufigkeit: Wintersemester ab WS 13/14	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 400	

Georg-August-Universität Göttingen **Modul B.Agr.0006: Grundlagen der Agrarpolitik und landwirtschaftlichen Marktlehre** *English title: Agricultural Policy and Agricultural Market Analysis*	6 C 6 SWS

Lernziele/Kompetenzen: Studierende können ökonomische Konzepte verwenden, um das Geschehen und die Wirkungszusammenhänge auf Agrarmärkten und in der Agrarpolitik zu analysieren. Sie verstehen die agrarpolitischen Entscheidungsprozesse der EU und sind in der Lage, die Interessen und Argumente der verschiedenen von dieser Agrarpolitik berührten Gruppen zu erläutern. Sie können alternative agrarpolitische Eingriffe in Hinblick auf ihre Marktwirkungen einordnen und aus gesamtwirtschaftlicher Sicht bewerten.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Grundlagen der Agrarpolitik und landwirtschaftlichen Marktlehre (Vorlesung, Übung) *Inhalte*: Marktlehre: Einführung in die ökonomische Analyse des Geschehens auf Agrarmärkten Agrarpolitik: Gestaltung und Auswirkungen agrarpolitischer Maßnahmen	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Klausur (30 Minuten) **Prüfungsanforderungen:** Eine Teilnahme an der Prüfungsvorleistung ist für die Teilnahme an der Modulprüfung verpflichtend. Die Prüfungsvorleistung muss nicht bestanden werden. Grundlegende Kenntnisse der Landwirtschaft und wirtschaftlichen Entwicklung, der Entwicklung der sektoralen Austauschverhältnisse, Basiskenntnisse über die Bestimmungsgründe der langfristigen Entwicklung der Agrarpreise und Begründungen für agrarpolitische Eingriffe sowie gesamtwirtschaftliche Bewertung agrarpolitischer Maßnahmen Grundlagenkenntnisse des landwirtschaftlichen Angebots, Grundlagen der Nachfrage nach Agrarprodukten und Lebensmitteln, Preisbildung auf vollkommenen Märkten und im Monopol, Marktspannen in der Wertschöpfungskette für agrarische Rohprodukte, agrarmarktpolitische Eingriffe und deren Beurteilung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Stephan von Cramon-Taubadel
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

400	

Georg-August-Universität Göttingen **Modul B.Agr.0010: Grundlagen der Phytomedizin und Pflanzenernährung** *English title: Introduction to Phytopathology and Plant Nutrition*	6 C 4 SWS

Lernziele/Kompetenzen: Im Rahmen des Teilmoduls Phytomedizin werden Kenntnisse zu Schad-ursachen im Pflanzenbau und Maßnahmen zu deren Vermeidung erworben. Die Studierenden lernen aktuelle Probleme im Pflanzenschutz kennen, Lösungsansätze zu entwickeln und gewonnene Kenntnisse in der Praxis anzuwenden. Das Modul ist Bestandteil des Sachkundenachweises nach der Bundessachkundeverordnung für die Anwendung chemischer Pflanzenschutzmittel. Im Rahmen des Teilmoduls Pflanzenernährung werden grundlegende Kenntnisse über das Verhalten von Nährstoffen im Boden und in der Pflanze vermittelt und daraus Methoden der Düngebedarfsermittlung abgeleitet. Die Studierenden werden befähigt, aktuelle Fragestellungen im Bereich der Pflanzenernährung, mit denen sie im Berufsleben konfrontiert werden, kompetent zu lösen. Die Studierenden sind in der Lage sich mit Fach-vertretern oder Laien über fachspezifische Fragestellungen austauschen.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden

Lehrveranstaltung: Grundlagen der Phytomedizin (Vorlesung) *Inhalte*: Struktur und Aufgaben der Phytomedizin, abiotische Schadursachen, wichtige Schadorganismen (Viren, Bakterien, Pilze, Nematoden, Milben und Insekten), wichtige Gegenspieler von Schadorganismen, Agrarökosysteme, Populationsdynamik von Schadorganismen, Prognosen und wirtschaftliche Schadensschwellen, Nutzung produktions-technischer Maßnahmen für den Pflanzenschutz (Bodenbearbeitung, Düngung, Fruchtfolge, Sortenwahl u. a. Maßnahmen der Anbau-, Ernte- und Lagertechnik), direkte Pflanzenschutzmaßnahmen (mechanische, thermische, chemische und biologische Verfahren), Bekämpfungsstrategien und Bekämpfungssysteme, wirtschaftliche Bedeutung des Pflanzenschutzes, Organisations- und Rechtsfragen.	2 SWS
Prüfung: Klausur (45 Minuten) **Prüfungsanforderungen:** Basiskenntnisse der Schaderreger in verschiedenen Kulturarten sowie Möglichkeiten zur Reduktion der Schadenswahrscheinlichkeit und gezielten Bekämpfung unter Berücksichtigung des integrierten Pflanzenschutzes und aller weiteren oben genannten Aspekte der Phytomedizin.	3 C

Lehrveranstaltung: Grundlagen der Pflanzenernährung (Vorlesung) *Inhalte*: Geschichtlicher Überblick zur Entwicklung der Vorstellungen über die Ernährung der Pflanze. Pflanzenfaktoren des Nährstoffaneignungsvermögens, Größe des Wurzelsystems, Nährstofftransport durch Biomembranen, Pflanzenverfügbarkeit von Nährstoffen im Boden (Prozesse und Faktoren), Funktion und Stoffwechsel der mineralischen Nährstoffe in der Pflanze, Wirkung auf Ertrag und Qualität. Vor diesem	2 SWS

Hintergrund werden Makro- und Mikronährstoffe abgehandelt. Nährstoffbilanzen, Düngebedarfsermittlung und Kontrolle des Ernährungszustandes von Pflanzen. Eigenschaften wirtschaftseigener sowie mineralischer Düngemittel. Gesetzlicher Rahmen der Düngung.	
Prüfung: Klausur (45 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse über die einzelnen Nährstoffe, ihr Verhalten im Boden, Aufnahme, Funktion und Stoffwechsel in der Pflanze, sowie Methoden der Düngebedarfsermittlung und Düngekontrolle, Düngemittel und ihre Eigenschaften.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas von Tiedemann
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 400	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.Agr.0013: Mathematik und Statistik
English title: Mathematics and Statistics</td><td>6 C
6 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Die Studierenden erwerben in diesem Modul die für ein naturwissenschaftliches Studium unabdingbaren Kenntnisse und Methoden in den Bereichen Mathematik und Statistik.

Die Vorlesung dient als Grundlage mehrerer weiterführender Module im Hauptstudium und soll der Auffrischung und der Vertiefung mathematischer und statistischer Kenntnisse dienen. Eine Vielzahl von praktischen Beispielen wird das Verständnis der theoretischen Konzepte erleichtern. Zu dem Modul werden Übungen angeboten, in denen der Stoff in häuslicher Arbeit vertieft werden soll. Die Übungsaufgaben werden in mehreren Übungsgruppen besprochen. In einer speziellen Übungsgruppe (für maximal 20 Teilnehmer mit soliden Vorkenntnissen in Mathematik und Statistik; Anmeldung erforderlich) werden die Übungsaufgaben zusätzlich mit dem Statistikpaket R im PC-Pool bearbeitet.</td><td>Arbeitsaufwand:
Präsenzzeit:
84 Stunden
Selbststudium:
96 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Mathematik und Statistik (Vorlesung, Übung)
Inhalte:
Maßeinheiten
Lineare Gleichungen mit einer und mehreren Unbekannten
Grundbegriffe der Mengenlehre
Spezielle Funktionen (z.B. Polynome, Exponential-/Logarithmusfunktionen)
Vektor- und Matrixrechnung
Deskriptive Statistik
Elementare Wahrscheinlichkeitsrechnung und Kombinatorik
Bedingte Wahrscheinlichkeit und stochastische Unabhängigkeit
Spezielle Wahrscheinlichkeitsvertretung (z.B. Binomial, Normal)
Graphische Methoden
Größenordnungen
Wichtige Begriffe auf englisch
Lage, Streu- und Konzentrationsmaße
Grundlagen des Hypothesentestens
Korrelation und Assoziation
Regression
Angebotshäufigkeit: jedes Wintersemester</td><td>6 SWS</td></tr>
<tr><td>Prüfung: Klausur (60 Minuten)
Prüfungsanforderungen:
Grundlagen der Mathematik
Arithmetik
Kombinatorik
Wahrscheinlichkeitsrechnung
Statistik</td><td>6 C</td></tr>
</table>

Zugangsvoraussetzungen:	Empfohlene Vorkenntnisse:

keine	keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Armin Schmitt
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 400	

Georg-August-Universität Göttingen **Modul B.Agr.0019: Einführung in die landwirtschaftliche Betriebslehre** *English title: Introduction to Farm Management*	6 C 6 SWS

Lernziele/Kompetenzen: Die Studierenden lernen wichtige betriebswirtschaftliche Begrifflichkeiten kennen und sind mit wichtigen betriebswirtschaftlichen Entscheidungssituationen vertraut. Sie erwerben das methodische Rüstzeug zur Lösung praktischer Entscheidungsprobleme und können einfache Analyse- und Planungsinstrumente in der Praxis anwenden. Die Studierenden sind in der Lage, in der landwirtschaftlichen Fachpresse veröffentlichte betriebswirtschaftliche Artikel zu verstehen und kritisch zu würdigen.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Einführung in die landwirtschaftliche Betriebslehre (Vorlesung, Übung) *Inhalte*: In diesem Modul wird das Augenmerk auf den einzelnen land- bzw. forstwirtschaftlichen Betrieb gerichtet und in die ökonomischen Probleme eingeführt, die bei seiner Bewirtschaftung auftreten. Gegenstand der Lehrveranstaltung ist die Vermittlung methodischen Grundlagenwissens und dessen Anwendung auf (einfache) Problemstellungen. Die Lehrinhalte lassen sich wie folgt gliedern: 1. Zur Unternehmensplanung und ihre Determinanten 2. Rechnungswesen und Controlling 3. Planungsgrundlagen 4. Produktionsplanung 5. Investitionsplanung 6. Finanzplanung 7. Betriebswirtschaft und umweltökonomische Fragestellungen	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse • des Aufbaus eines Jahresabschlusses • der Leistungs-Kosten-Rechnungs-Systeme • von Planungsprinzipien • der optimalen speziellen Intensität • der Minimalkostenkombination • der finanzmathematische Grundlagen • der Rentabilitätskriterien einer Investition • von Zins- und Tilgungsplänen	6 C

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	keine

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Oliver Mußhoff
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 450	

Georg-August-Universität Göttingen **Modul B.Agr.0020: Food Chain Management und Welternährung** *English title: Food Chain Management and Global Food Security*	6 C 4 SWS
Lernziele/Kompetenzen: Studierende erlernen grundsätzliche Techniken des wissenschaftlichen Arbeitens und wenden Sie im Rahmen von Ernährungsfragen und benachbarten Gebieten zur effizienten und sachgerechten Versorgung von KonsumentInnen europa- wie weltweit an. Die Studierenden sind in der Lage aktuellen Weltproblemen im Zusammenhang mit der Lebensmittelversorgung von Bevölkerungen zu folgen, Sie wissenschaftlich zu ergründen und diese eigenständig zu bewerten.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
Lehrveranstaltung: Food Chain Management (Vorlesung) *Inhalte*: Food Chain Management beinhaltet die betriebswirtschaftlichen Grundlagen des Managements in der gesamten Wertschöpfungskette der Lebensmittelwirtschaft (von der Vorleistungsindustrie bis zum Lebensmitteleinzelhandel).Die Studierenden erhalten einen fundierten Überblick über die ökonomischen Strukturen des vorgelagerten Sektors (Agribusiness im engeren Sinne) und die der Landwirtschaft nachgelagerten Verarbeitungs- und Handelsstufen. Auf Basis dieser zunächst deskriptiven Darstellungen erhalten sie dann das methodische Rüstzeug zum Verständnis von betriebswirtschaftlichen Prozessen in der komplexen, arbeitsteiligen Wertschöpfungskette. Sie lernen, welche Tätigkeitsfelder ausgelagert werden können, welche Vertragssysteme ggf. angewandt werden sollten, mit welchen Instrumenten Geschäftsbeziehungen verbessert werden können usw. Diese Fähigkeiten bereiten unmittelbar auf die Tätigkeit in den Industrie- und Handelsunternehmen der Agrar- und Ernährungswirtschaft vor.	2 SWS
Prüfung: Klausur (45 Minuten) **Prüfungsanforderungen:** Basiskenntnisse der Strukturen der Wertschöpfungskette bei Lebensmitteln, Konzentrationsprozesse, Angebots- und Nachfragemacht, grundlegende Kenntnisse der Koordinationsformen in arbeitsteiligen Wertschöpfungsketten, vertikales Marketing, Vertragslandwirtschaft, Marktorientierung	3 C
Lehrveranstaltung: Welternährung (Vorlesung) *Inhalte*: Welternährung führt die Studierenden in eine Reihe globaler Themen ein, die mit dem Welternährungsproblem, den verschiedenen Formen der Unterernährung und nachhaltigen Ernährungssystemen zusammenhängen. Das Modul bietet einen Überblick über den Zustand der globalen Landwirtschaft, der Lebensmittel und der Ernährung in der Welt, basierend auf globalen und regionalen Statistiken. In einer historischen Perspektive werden die Studierenden mit der Entwicklung von Armut, Hunger und anderen Formen der Unterernährung in der Welt sowie mit der Rolle der landwirtschaftlichen Entwicklung und der wirtschaftlichen Mechanismen in diesem Zusammenhang vertraut gemacht. Schließlich wird das Konzept der nachhaltigen	2 SWS

Lebensmittelsysteme als Rahmen für die Analyse der Zusammenhänge zwischen dem Agrarsektor, der menschlichen Gesundheit wie der der Ökosysteme vorgestellt.	
Prüfung: Klausur (45 Minuten) **Prüfungsanforderungen:** Ein allgemeines Verständnis der Konzepte der internationalen ländlichen Entwicklung, der globalen Ernährung und der nachhaltigen Ernährungssysteme. Grundlegende Einblicke in die regionale Verteilung, die historische Entwicklung und die wirtschaftlichen Mechanismen der Welternährung.	3 C

Prüfungsanforderungen: Ein allgemeines Verständnis der Konzepte der internationalen ländlichen Entwicklung, der globalen Ernährung und der nachhaltigen Ernährungssysteme. Grundlegende Einblicke in die regionale Verteilung, die historische Entwicklung und die wirtschaftlichen Mechanismen der Welternährung.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Liesbeth Colen
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3
Maximale Studierendenzahl: 400	

Bemerkungen: Verantwortliche der Teilmodule: Prof. Dr. Liesbeth Colen (Welternährung); Dr. Holger Bergmann (Food Chain Management)

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.Agr.0021: Nutztierwissenschaften I: Tierernährung und Tierhygiene
English title: Farm Animal Sciences I: Animal Nutrition and Hygiene</td><td>6 C
4 SWS</td></tr>
</table>

<table>
<tr><td>Lernziele/Kompetenzen:
Die Studierenden erwerben grundlegende Kenntnisse in den Fachgebieten Tierernährung und Tierhygiene. Sie kennen wichtige Konzepte, Termini und Eckzahlen dieser Bereiche und können diese auf grundlegende Fragestellungen anwenden. Darüber hinaus erhalten sie einen Überblick über Kriterien zur Qualitätsbewertung tierischer Produkte. Auf der Basis des Moduls können sie grundlegende Fachliteratur nutzen, sich mit Fachvertretern austauschen und aktuelle Fragestellungen diskutieren.</td><td>Arbeitsaufwand:
Präsenzzeit:
56 Stunden
Selbststudium:
124 Stunden</td></tr>
</table>

<table>
<tr><td>Lehrveranstaltung: Nutztierwissenschaften I: Tierernährung und Tierhygiene (Vorlesung, Übung)
Inhalte:
Prinzipien und Grundlagen der Tierernährung, Tierhygiene und Produktqualität werden den Studierenden anhand praktischer Beispiele nähergebracht und verdeutlicht.

Grundsätze der Tierernährung: Futterinhaltsstoffe (Bedeutung; Grundzüge Futtermittelanalytik); Grundlagen von Verdauungssystemen und Verdauungsprozessen incl. Konsequenzen für Energie- und Nährstoffverwertung; Grundlagen der Futterbewertung für Nutztiere und Anwendung von Futterbewertungssystemen; Futtermittelrechtliche Grundlagen; wichtige Futtermittelgruppen; Fütterungsgrundsätze der wichtigsten Nutztierarten.

Grundsätze der Tier- und Lebensmittelhygiene: Produktionskrankheiten; Infektiöse Krankheiten; Einsatz von Arzneimitteln; Tierseuchen und Seuchenbekämpfung; Lebensmittelhygiene.

Einführung in die Qualitätsbewertung tierischer Produkte.

Ergänzende Übungen zu fütterungsrelevanten Rechnungen und Futtermittelkunde.</td><td>4 SWS</td></tr>
<tr><td>Prüfung: Klausur (90 Minuten)
Prüfungsanforderungen:
Tierernährung: Hauptnährstoffe - Erfassung und grundlegende Funktionen im Stoffwechsel; Verdauung und Bewertung der Verdauungsprozesse bei verschiedenen Nutztierarten; Bewertung von Futterenergie und -protein; Grund- und Handelsfuttermittel - Basiskenntnisse Futterwertdaten und futtermittelrechtlicher Rahmen; Fütterungsgrundsätze - Schwerpunkt Milchvieh, Schwein, Geflügel

Tierhygiene: Basiszusammenhänge Produktionskrankheiten, Infektionskrankheiten und Tierseuchen; Grundlagen Lebensmittelhygiene

Produktqualität: Grundlagen der Qualitätsbeurteilung tierischer Erzeugnisse - Schwerpunkt Fleisch, Milch und Eier</td><td>6 C</td></tr>
</table>

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	B.Agr.0003, B.Agr.0025

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jürgen Hummel
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2
Maximale Studierendenzahl: 400	

Bemerkungen: Verantwortliche der Teilbereiche: Prof. Dr. Jürgen Hummel (Tierernährung); Prof. Dr. Jens Tetens (Tierhygiene); Prof. Dr. Daniel Mörlein (Produktqualität)

Georg-August-Universität Göttingen **Modul B.Agr.0022: Nutztierwissenschaften II: Tierzucht und Reproduktion** *English title: Farm Animal Sciences II: Animal Breeding and Reproduction*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erwerben theoretische und praktische Kenntnisse über die verschiedenen Arbeitstechniken der Reproduktion und sind mit den dafür relevanten anatomischen Unterschieden der verschiedenen Nutztierarten vertraut. Die relevanten Fachbegriffe werden von den Studierenden beherrscht, so dass sie in der Lage sind sich mit Fachleuten auszutauschen. Die Studierenden verstehen die wichtigsten methodischen Grundlagen der Tierzucht wie: Vererbungsmodelle, Populationsgenetik und quantitative Genetik, Selektionstheorie und können diese Grundlagen auf die verschiedenen Nutztierarten anwenden. Sie kennen und verstehen den Einfluss der Rahmenbedingungen auf die Zucht der verschiedenen Nutztierarten. Sie sind mit den wesentlichen Strukturen der Zuchtprogramme bei den wichtigsten Nutztierspezies vertraut.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Nutztierwissenschaften II: Tierzucht und Reproduktion (Vorlesung) *Inhalte*: • Anatomische, physiologische Grundlagen der Reproduktion • Reproduktionsbiotechnologische Grundlangen von Belegung und Besamung • Grundlagen von Embryologie, Trächtigkeit und Laktation • Methodische Grundlagen der Tierzüchtung • Rahmenbedingungen der Tierzüchtung • Zuchtprogramme bei Rind, kleinen Wiederkäuern, Schwein, Pferd und Huhn	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse folgender Lehrinhalte: • Anatomische, physiologische Grundlagen der Reproduktion • Reproduktionsbiotechnologische Grundlangen von Belegung und Besamung • Grundlagen von Embryologie, Trächtigkeit und Laktation • Methodische Grundlagen der Tierzüchtung • Rahmenbedingungen der Tierzüchtung • Zuchtprogramme bei Rind, kleinen Wiederkäuern, Schwein, Pferd und Huhn	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Michael Hölker; N.N.
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3
Maximale Studierendenzahl: 400	

Georg-August-Universität Göttingen **Modul B.Agr.0023: Pflanzenbau, Pflanzenzüchtung und Graslandwirtschaft** *English title: Agronomy, Plant Breeding and Grassland Science*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erlernen die pflanzenbaulichen Zusammenhänge zwischen Boden, Pflanze und Umwelt. Sie sind in die Lage versetzt, pflanzenbauliche Möglichkeiten der Ertragsbildung zu nutzen, aber auch die ökologischen Restriktionen pflanzenbaulicher Systeme zu bewerten und können diese in die pflanzenbaulichen Handlungsabläufe integrieren. Am Beispiel eines zweifaktoriellen Experiments lernen sie Wechselwirkungen in pflanzenbaulichen Nutzungssystemen sowohl fachlich als auch mathematisch-statistisch richtig zu interpretieren. Die Studierenden kennen Kategorien und Methoden der Pflanzenzüchtung und können Zusammenhänge mit Züchtungszielen und Sortenschutz herstellen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Pflanzenbau, Pflanzenzüchtung und Graslandwirtschaft (Vorlesung) *Inhalte*: Gesamtüberblick über den landwirtschaftlichen Pflanzenbau sowie wichtiger Themenbereiche aus den Fachgebieten Grünlandlehre und Pflanzenzüchtung. Grundkenntnisse über die wichtigsten in Mitteleuropa angebauten Kulturpflanzen und deren Produktionsverfahren, physiologische und ökologische Faktoren der Substanzproduktion, Bodenbearbeitung, Fruchtfolgen, Humuswirtschaft, Pflanzenentwicklung und Ertragsbildung, Anlage und Pflege von Wiesen und Weiden, Grünlandbewirtschaftung. Die Teilnehmer erhalten einen Überblick über das Gebiet der Pflanzenzüchtung, einschließlich Geschichte und aktuelle Entwicklungen der Pflanzenzüchtung, grundlegende Evolutionstheorie und Genetik in Bezug auf Züchtungsziele, Kategorien der Pflanzenzüchtung im Zusammenhang mit dem Sortenwesen. Beziehung zwischen Genotypen und Phänotypen. Die Grundsätze der Feldversuchsgestaltung werden ebenfalls behandelt.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse des Ackerbaus, des Allgemeinen und speziellen Pflanzenbau sowie des Futterbaus und der Graslandwirtschaft, Basiswissen über Kategorien und Methodik der Pflanzenzüchtung, Züchtungsziele und Sortenschutz.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Stefan Siebert
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3

Maximale Studierendenzahl: 400	

Georg-August-Universität Göttingen **Modul B.Agr.0024: Nutztierwissenschaften III: Nutztierhaltung und Agrartechnik Innenwirtschaft** *English title: Farm Animal Sciences III: Farm Animal Husbandry and Agricultural Engineering in Livestock Systems*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden lernen die wichtigsten haltungsphysiologischen, ethologischen und technischen Grundlagen der Nutztierhaltung kennen. Sie können auf Grundlage dieser Kenntnisse verschiedene Haltungssysteme und Stallformen beurteilen und bewerten. Sie kennen die verschiedenen tierartspezifischen Organisationsformen in der Nutztierhaltung und können deren Vor- und Nachteile einordnen. Sie erlangen grundlegende Kenntnisse in die Lüftungstechnik und den dazugehörigen Stallbau von Nutztierställen. Sie lernen die Grundlagen der Fütterungs- und Melktechnik kennen und sind in der Lage, die technischen Vorgänge zu erläutern und die Systeme in ihrer Eignung für bestimmte Tiergruppen oder Betriebe zu bewerten	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Nutztierwissenschaften III: Nutztierhaltung und Agrartechnik Innenwirtschaft (Vorlesung, Übung) *Inhalte*: Haltungsphysiologische und ethologische Grundlagen der Tierhaltung, Organisationsformen in der Nutztierhaltung, Grundlagen der Agrartechnik Innenwirtschaft wie Melken, Stalllüftung und Fütterungstechnik	4 SWS
Prüfung: Klausur (60 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse folgender Lehrinhalte: - Haltungsphysiologische und ethologische Grundlagen der Tierhaltung - Organisationsformen in der Nutztierhaltung – Kenntnisse der verschiedenen Lüftungsmöglichkeiten für Ställe inkl. der physikalischen und stallbaulichen Grundlagen, Kenntnisse des Melkprozesses sowie Aufbau und Formen von Melkanlagen, Grundlagen der Fütterungstechnik	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. agr. Sabrina Elsholz
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3
Maximale Studierendenzahl: 400	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.Agr.0025: Chemie und Physik
English title: Chemistry and Physics</td><td>6 C
4 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Die Studierenden erwerben Basiswissen der Allgemeinen, Anorganischen und Organischen Chemie, sowie der Physik und können diese Kenntnisse in anderen Fachgebieten anwenden.</td><td>Arbeitsaufwand:
Präsenzzeit:
56 Stunden
Selbststudium:
124 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Chemie (Vorlesung)
Inhalte:
Allgemeine und anorganische Chemie
Grundbegriffe, Einteilung der Stoffe, Aggregatzustände, Atombau, Periodensystem der Elemente, Grundtypen chemischer Bindungen und Reaktionen, chemisches Gleichgewicht, Säure-Base-Chemie, Redoxchemie, Metallkomplexe
Organische Chemie
Kohlenwasserstoffe, Verbindungen mit einfachen funktionellen Gruppen, wie Alkohole, Phenole, Ether, Amine und Carbonylverbindungen, Aromaten, ausgewählte Reaktionsmechanismen</td><td></td></tr>
<tr><td>Prüfung: Klausur (60 Minuten)
Prüfungsanforderungen:
Kenntnisse über die Grundlagen der Chemie aus allgemeiner, anorganischer und organischer Chemie und die Anwendung des erworbenen Wissens zur Lösung von Fachaufgaben.</td><td>3 C</td></tr>
<tr><td>Lehrveranstaltung: Physik (Vorlesung)
Inhalte:
Inhalte:
Grundlagen der Mechanik, Einheiten und -systeme, Kinematik (Translation, Rotation, Schwingungen und Wellen), Dynamik (u.a. Newton’sche Axiome), Energie und -erhaltung, Impuls
Elemente der Wärmelehre
thermodynamische Kenngrößen, Wärme- und Feuchteübertragung Mollier-h-x-Diagramm, Wärmetransport, erster Hauptsatz der Thermodynamik, kinetische Gastheorie
Grundlagen der Elektrotechnik
Grundlagen der Strömungsmechanik (Fluide und ihre Eigenschaften, Druck, Druckausbreitung, Strömungsformen)</td><td>2 SWS</td></tr>
<tr><td>Prüfung: Klausur (60 Minuten)
Prüfungsanforderungen:
Anwendung physikalischer Grundlagen, Anwendung von Formeln und Diagrammen zur Lösung von Aufgaben.</td><td>3 C</td></tr>
</table>

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. nat. Susann Graupner
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1
Maximale Studierendenzahl: 250	

Georg-August-Universität Göttingen **Modul B.Agr.0026: Agrartechnik I - Grundlagen der Agrartechnik / Außenwirtschaft** *English title: Agricultural Engineering I – Fundamentals of Agricultural Engineering in Arable Farming Applications*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen Kenntnisse und Grundwissen über Maschinen, Geräte und technische Einrichtungen aus der Pflanzenproduktion und werden mit deren grundsätzlichem Aufbau und der Funktionsweise vertraut gemacht. Es werden System- und Verfahrenszusammenhänge erlernt, um technische Hilfsmittel im pflanzenbaulichen System fachgerecht auswählen zu können sowie Alternativen zu beurteilen. Das erworbene Wissen befähigt die Studierenden technische Zusammenhänge im Beruf zu erkennen und das Erlernte für ihre praktischen Tätigkeiten zur Anwendung zu bringen. Sie sind in der Lage, mit ihrem erlangten Basiswissen weiterführende Module zu belegen und können technische Problemstellungen erkennen und lösen. Sie können zu fachlichen Aufgaben aus dem Pflanzenbau die passende Technik auswählen sowie für Maschinen deren Funktionen und Einsatzzweck ableiten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Agrartechnik I - Grundlagen der Agrartechnik / Außenwirtschaft *Inhalte*: Das Modul beschäftigt sich mit den Grundlagen der Verfahrenstechnik zur Pflanzenproduktion und den im Pflanzenbau eingesetzten Maschinen. Zum Lehrinhalt für den verfahrenstechnischen Teil gehören Aufbau und Funktionsweise von Landmaschinen, Motorentechnik, Reifen / Fahrwerk, Ackerschlepper, Bodenbearbeitungs- und Sätechnik, Düngetechnik, Pflanzenschutztechnik und Erntetechnik. Weitere Themen sind Grundlagen der Agrarlogistik sowie Grundlagen des Precision Farming.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Verfahrenstechnische Zusammenhänge in der Pflanzenproduktion, Aufbau und Funktionsweise von Geräten und technischen Einrichtungen zur Pflanzenproduktion, Grundlagen des Erkennens und Einordnens von technischen Zusammenhängen, Anforderungen an Technik für den Pflanzenbau.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Frank Beneke
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2

Maximale Studierendenzahl: 400	

Georg-August-Universität Göttingen **Modul B.Agr.0305: Agrarpreisbildung und Marktrisiko** *English title: Price Formation and Market Risk*	6 C (Anteil SK: 6 C) 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben ein vertieftes Verständnis für Preisbildungsprozesse, die das Ergebnis auf den Märkten der Agrar- und Ernährungswirtschaft bestimmen, und sind informiert über Besonderheiten der Preisbildung auf Agrarmärkten, insbesondere die Preisbildung für den Produktionsfaktor Boden und die Preisbildung auf quotierten Märkten. Die Studierenden erlernen an Beispielen aus der Praxis, wie zeitliche und räumliche Preisbildungsprozesse ablaufen und wie Preise auf räumlich getrennten Märkten bzw. für Produkte von unterschiedlichem Verarbeitungsgrad zusammenhängen. Sie können die Bedeutung und Nutzung von Warenterminmärkten in der Landwirtschaft sowie in vor- und nachgelagerten Branchen einschätzen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Agrarpreisbildung und Marktrisiko (Vorlesung) *Inhalte*: Kern des Moduls ist eine umfassende Behandlung der Preisbildung auf landwirtschaftlichen Produkt- und Faktormärkten, bei besonderer Berücksichtigung von Warenterminmärkten und mikroökonomische Grundlagen der Volkswirtschaftslehre mit Bezug auf Märkte der Agrar- und Ernährungswirtschaft.	
Prüfung: Klausur (90 Minuten)	6 C
Prüfungsanforderungen: Bedeutung von Preisen aus individueller und gesamtwirtschaftlicher Sicht; Agrarpreisgefüge; Bedeutung des technischen Fortschritts; vertikale und räumliche Preisbildung; Preisbildung auf dem Bodenmarkt; Preisbildung auf quotierten Märkten; Warenterminmärkte.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Dringende Empfehlung: Grundlagen der Agrarpolitik und landwirtschaftlichen Marktlehre oder äquivalent
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Bernhard Brümmer
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Agr.0306: Aquakultur I** *English title: Aquaculture I*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erlangen Kenntnisse über die theoretischen Grundlagen der Kultivierung von Süßwasserfischen auf den wichtigsten Intensitätsstufen von der Ranchwirtschaft über Teichwirtschaften bis hin zu Kreislaufsystemen unter besonderer Berücksichtigung der Zucht und Haltung der wichtigsten Nutzfischarten sowie deren Wechselbeziehung zur Haltungsumwelt. Sie können die verschiedenen Aquakultursysteme hinsichtlich ihrer Ressourcennutzung und -pflege analysieren und bewerten sowie Entwicklungsmöglichkeiten dieser Systeme ableiten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Aquakultur I (Vorlesung, Übung) *Inhalte*: Zentrale Inhalte sind die Anatomie und Physiologie wechselwarmer Tiere, hydrobiologische und hygienische Aspekte der Fischhaltung, Kultivierungssysteme, Fütterung und Zucht von Nutzfischen, Produkte aus der Aquakultur, ihre Qualitätsbewertung und Vermarktungsformen.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlagen der Anatomie und Physiologie von Süßwasserfischen, hydrobiologische und hygienische Grundlagen der Fischhaltung und Kultivierung von Süßwasserfischen inklusive Fütterung, Zucht, Produktqualität, Umweltwirkungen	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Simon Rosenau
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul B.Agr.0307: Betriebswirtschaftslehre des Agrar- und Ernährungssektors** *English title: Agribusiness Management*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen die strukturellen Spezifika der Branche, die im Mittelpunkt des Studiums der Agrarwissenschaften stehen, kennen und verstehen. Sie erlernen für ihr weiteres Studium und die spätere praktische Tätigkeit zentrales Faktenwissen und vermögen auf dieser Grundlage, weiterführende Problemstellungen zu erarbeiten und zu lösen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Standortlehre (Vorlesung) *Inhalte*: Gegenstand des Teilmoduls Standortlehre sind verschiedene Standorttheorien sowie die Vermittlung von Kenntnissen über die räumliche Verteilung der Agrarproduktion (national, international) und deren Bestimmungsgründe.	2 SWS
Prüfung: Klausur (60 Minuten) **Prüfungsanforderungen:** Umfassende Kenntnisse bezüglich - Standorttheorien - Bestimmungsgründe der Anordnung der Agrarproduktion im Raum - Internationale Wettbewerbsfähigkeit der Landwirtschaft – Entwicklung der räumlichen Anordnung der Landwirtschaft in Deutschland und weltweit.	3 C
Lehrveranstaltung: Organisationsstrukturen (Seminar) *Inhalte*: Im Organisationsstrukturen werden die Grundlagen des wissenschaftlichen Arbeitens behandelt, des Weiteren werden ausgewählte aktuelle und relevante Themen aus der Agrar- bzw. Ernährungswirtschaft oder der Agrarinformatik behandelt. Es muss hier eine der folgenden Optionen gewählt werden: 1. Standortlehre (Isermeyer) und Agrar aktuell (Theuvsen) (Option 1) oder 2. Standortlehre (Isermeyer) und Agrar- und Ernährungswirtschaft (Spiller) (Option 2) oder 3. Standortlehre (Isermeyer) und Agrarinformatik (Theuvsen) (Option 3)	2 SWS
Prüfung: Referat (ca. 15 Minuten, Gewichtung 25%) und Hausarbeit (max. 8 Seiten, Gewichtung 75%) **Prüfungsanforderungen:** Umfassende Kenntnisse der • aktuellen Agrarwirtschaft • Agrar- und Ernährungswirtschaft • Agrarinformatik Prüfungsleistung für 2 Personen (Hausarbeiten): Präsentation, Referat oder Korreferat (ca. 30 Minuten, Gewichtung 25%) und Hausarbeit (max. 16 Seiten, Gewichtung 75%)	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Achim Spiller
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 200	

Bemerkungen: Die im jeweils aktuellen Sommersemester angebotenen Optionen können unterhttps://univz.uni-goettingen.de/in der Veranstaltung „Organisationsstrukturen“ eingesehen werden.

Georg-August-Universität Göttingen **Modul B.Agr.0314: Futterbau und Graslandwirtschaft** *English title: Pasture Management and Forage Production*	6 C 4 SWS
Lernziele/Kompetenzen: Studierende lernen die theoretischen Grundlagen der Produktionssysteme des Futterbaus und der Graslandwirtschaft kennen. Sie können Anbau- und Produktionssysteme auf verschiedenen Skalenebenen (Flächen, Betrieb) im Hinblick auf das Zusammenspiel von Standort-, Kulturartabhängige und Bewirtschaftungsfaktoren analysieren. Sie sind in der Lage, Futterproduktionssysteme in der Praxis zu analysieren und im Hinblick auf die agronomische, futterbauliche und umweltrelevante Effizienz zu bewerten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Futterbau und Graslandwirtschaft (Vorlesung, Übung) *Inhalte*: Futterbau: Bedeutung und Formen des Futterbaus, Zwischen-, Zweit- und Hauptfruchtfutterbau, Klima- und Bodenansprüche des Futterbaus, Kulturarten des Futterbaus, Grundsätze der Arten- und Sortenwahl, Grundlagen der Ertragsbildung, Produktionstechnik: Düngung, Bodenbearbeitung, Fruchtfolge, Anbauverfahren, Futterqualität, Futterkonservierung, Futternutzung. Graslandwirtschaft: Bedeutung der Graslandwirtschaft, Grundlagen des Graslandwuchses, Boden, Klima, Wasser, Pflanzenbestände des Graslandes, Wachstum, Entwicklung und Ertragsbildung, Bewirtschaftung des Graslandes, Anlage, Düngung, Pflege, Graslandnutzung, Futterqualität, Weidewirtschaft, Schnittnutzung, Heu- und Silagebereitung. Identifikation, Biologie, Ökologie, Ertragsleistung und Futterqualität von Kulturarten des Futterbaus und Pflanzenarten des Dauergraslands, vegetationskundliche Methoden, Technik der Weidewirtschaft, Feldmethoden zur futterbaulichen Bewertung von Grasland und Futterpflanzenbeständen, Methoden graslandwirtschaftlicher Forschung. Durchführung einer Projektarbeit, in der Studierende eigenständig eine Analyse eines Futterproduktionssystems auf einem selbstgewählten landwirtschaftlichen Betrieb durchführen. Vortrag der Ergebnisse im Rahmen des Seminars.	4 SWS
Prüfung: Klausur (90 Minuten, Gewichtung 80%) und Referat (ca. 15 Minuten, Gewichtung 20%) **Prüfungsanforderungen:** Einführende Kenntnisse der Bewertung und Analyse eines Praxisbeispiels futterbaulicher Planung, Beherrschung der grundlegenden Methoden und Inhalte der Futterbau- und Graslandwissenschaft Prinzipielle Kenntnis und sachgerechte Beherrschung bzw. Anwendung der theoretischen und methodischen Inhalte des Moduls.	6 C

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**

keine	keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Johannes Isselstein
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Agr.0315: Geländekurs Bodenwissenschaften: Grundlagen und Aspekte** *English title: Field Course in Soil Science: Fundamentals of Soil Science*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden können die Bodenbildungen auf den Gesteinen des Göttinger Raumes darlegen, die Auswirkungen des Bodenwassers auf die Bodenbildung erläutern und diese Kenntnisse entsprechend übertragen. Sie verfügen über grundlegende Kenntnisse zur Oberflächengestaltung durch eiszeitliche Phänomene und kennen die Bedeutung des Menschen zur Landschaftsnutzung und -geschichte.	**Arbeitsaufwand:** Präsenzzeit: 58 Stunden Selbststudium: 122 Stunden

Lehrveranstaltung: Geländekurs Bodenwissenschaft: Grundlagen und Aspekte (Vorlesung, Exkursion) *Inhalte*: Geländekurs im Göttinger Raum, Leinetalgraben und angrenzender Region: • Bodenbildende Gesteine • Periglaziale Prozesse • Formen organischer Substanz • Bodengefüge und -strukturen • Formen und Dynamik des Bodenwassers • Prozess-Abläufe in Pelit-, Kalkstein-, Löß- und Sandböden • Bodentaxonomie • Bodengeschichte	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlagen der geologischen Formationen, Geomorphologie und Genese des Göttinger Raumes; Bodenbildung auf den Substraten Ton, Sand, Kalk u. Löss; Siedlungsgeschichte	6 C

Zugangsvoraussetzungen: Kenntnisse aus den im Modul "Bodenkunde und Geoökologie" behandelten Themenbereichen werden erwartet.	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Peter Gernandt
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Modul B.Agr.0316: Geoökologie und abiotischer Ressourcenschutz** *English title: Geo-ecology and Abiotic Resource Protection*	6 C 8 SWS
Lernziele/Kompetenzen: Die Studierenden kennen die Bodengesellschaften in ihren unterschiedlichen Nutzungs- und Systemsteuerungsmöglichkeiten exemplarisch am Beispiel der Böden Norddeutschlands. Sie können die Auswirkungen agrarischer Nutzungen an Fallbeispielen verschiedener Bodentypengesellschaften diskutieren und Lösungsmöglichkeiten aufzeigen und diese auf ihre beruflichen Tätigkeiten übertragen. Sie sind in der Lage die Bodenschutzgesetzgebungen und Verordnungen auf die Handlungsweisen der agrarischen Nutzung anzuwenden. Sie erkennen den besonderen Aspekt der Humusdynamik auf die Klimarelevanz und können entsprechende Handlungsempfehlung in der Praxis fundiert beurteilen.	**Arbeitsaufwand:** Präsenzzeit: 106 Stunden Selbststudium: 74 Stunden
Lehrveranstaltung: Geoökologie und abiotischer Ressourcenschutz (Vorlesung, Exkursion, Übung) *Inhalte*: Landschaftsgenese und Bodengesellschaften Norddeutschlands, Steuerungsmöglichkeiten für die Elementar-, Energie- und Wasserhaushalte agrarischer Ökotope; Wasserschutzgebietsstrategien; Ökogeographie landwirtschaftlicher Bodennutzungssysteme, Naturgut- und Ressourcenschutz im Bereich der Pedo-, Hydro-, Atmosphäre; Bodenschutz lt. Bodenschutzgesetz. Es werden Grundlagen des Stofftransports im Boden und der Hydrogeologie vermittelt. Darauf aufbauend wird die Dynamik des Stoffaustrags aus landwirtschaftlichen Böden in die Atmosphäre und in aquatische Ökosysteme behandelt. Der Lehrstoff wird in 2 Exkursionen (1 Tag Harz und Harzvorland, 2 Tage Geest und Hochmoor - Küstensaum) exemplarisch dargestellt. *Angebotshäufigkeit:* Sommersemester ab SoSe 13	8 SWS
Prüfung: Präsentation, Referat oder Korreferat (ca. 20 Minuten) oder mündliche Prüfung (ca. 30 Minuten) **Prüfungsanforderungen:** Dezidierte Kenntnisse der Bodengesellschaften Norddeutschlands, Bodenschutzkonzeptionen und Anwendung auf die Dynamik des Standorts; Speicher-, Transport- und Umsatzprozesse im System Boden-Atmosphäre-Grundwasser-Oberflächengewässer; Anwendung im Hinblick auf den Verbleib von Stickstoff- und Phosphorverbindungen sowie Pflanzenschutzmitteln.	6 C

Zugangsvoraussetzungen: Kenntnisse aus den im Modul "Bodenkunde und Geoökologie" behandelten Themenbereichen werden erwartet.	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Peter Gernandt

Angebotshäufigkeit: Sommersemester ab SoSe 2013	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Agr.0319: Wissenschaftliches Arbeiten und Präsentieren in der Pflanzenproduktion (WAP)** *English title: Scientific Writing and Presentation in Crop Sciences*	6 C (Anteil SK: 6 C) 4 SWS

Lernziele/Kompetenzen: Das Modul dient der gezielten Vorbereitung auf die Bachelorarbeit. Die Studierenden sollen in die Lage versetzt werden eine Arbeit eigenständig zu erstellen und wissenschaftliche Inhalte in geeigneter Form zu präsentieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Wissenschaftliches Arbeiten und professionelles Präsentieren in der Pflanzenproduktion (Vorlesung, Übung) *Inhalte*: Es werden grundsätzliche Techniken wissenschaftlichen Arbeitens, die von Bachelorabsolventen der Studienrichtung Pflanzenproduktion verlangt werden, vermittelt. Dazu zählen: Literaturbeschaffung, Literaturauswertung, Darstellung von Ergebnissen in Tabellen und Grafiken, einfache statistische Auswertungen, Gestaltung von Vorträgen und Handouts, Präsentationstechniken, Abfassung einer schriftlichen wissenschaftlichen Arbeit. Im Seminarteil des Moduls können sich die Studierenden ein Thema aus dem Bereich der Pflanzenproduktion wählen. Zu diesem Thema halten die Studierenden einen Vortrag. Das Thema des Vortrages wird auch Thema der Hausarbeit sein, bei der die Studierenden die erlernten Techniken unmittelbar anwenden können.	4 SWS
Prüfung: Präsentation (ca. 20 Min., deutsch oder englisch) mit schriftlicher Ausarbeitung (max. 1 Seite) (50%) und Hausarbeit (max. 12 Seiten ohne Verzeichnisse, deutsch oder englisch) (50%) **Prüfungsvorleistungen:** Regelmäßige Teilnahme an den Übungen **Prüfungsanforderungen:** Bewertung des Seminarvortrags (einschließlich Handouts), der Hausarbeit, sowie der Moderation und der Beteiligung an der Lehrveranstaltung	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Wechselnd
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 60	

Georg-August-Universität Göttingen **Module B.Agr.0320: Introduction to Tropical and International Agriculture**	6 C 4 WLH

Learning outcome, core skills: Die Studierenden kennen die Auswirkungen biophysikalischer Rahmenbedingungen auf die Produktion(-smöglichkeiten) von Landwirten in Entwicklungs- und Schwellenländern. Sie sind in der Lage, die sozioökonomischen Rahmenbedingungen hinsichtlich ihrer Auswirkung auf landwirtschaftliche Produktionssysteme zu beurteilen. Sie können sich selbständig mit englischsprachiger Fachliteratur neues Wissen aneignen.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Introduction to tropical and international agriculture (Lecture) *Contents*: Das Modul vermittelt einen grundlegenden Überblick über die biophysikalischen und sozioökonomischen Gegebenheiten in den sogenannten Entwicklungs- und Schwellenländern in Afrika, Asien und Lateinamerika. An ausgewählten Beispielen, die von der Subsistenzlandwirtschaft bis zu modernen marktorientierten Betrieben reichen, werden die Chancen und Beschränkungen aufgezeigt, mit denen Pflanzenbau, Tierhaltung und Produktvermarktung an diesen Standorten konfrontiert sind. Anhand von ausgewählten Publikationen internationaler Zentren (z.B. CGIAR, FAO, Weltbank) verschaffen sich die Studierenden im Selbststudium einen breiteren Überblick über die in der Vorlesung angesprochenen Themen.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Grundlegende Kenntnisse: Definition der Tropen/Subtropen; standortspezifische Aspekte der tropischen und internationalen Landwirtschaft aus pflanzenbaulicher, tierhalterischer und sozio-ökonomischer Sicht	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Eva Schlecht
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 100	

Georg-August-Universität Göttingen **Modul B.Agr.0322: Methodische Grundlagen für Agrarökonomen** *English title: Introduction to Mathematics and Statistics for Agricultural Economists*	6 C (Anteil SK: 6 C) 6 SWS
Lernziele/Kompetenzen: Studierende sind in der Lage, mathematische und statistische Methoden anzuwenden, um Analysen des Geschehens in der Landwirtschaft und auf Märkten für Agrarprodukte und Produktionsfaktoren sowie der Auswirkungen von agrar- und wirtschaftspolitischen Maßnahmen auf diesen Märkten selbstständig zu erstellen. Studierende können die Ergebnisse dieser Analysen in geeigneter tabellarischer und graphischer Form darstellen und diese sowohl Fachvertretern als auch Laien gegenüber erläutern. Sie können eigene Analysen und einfache Programmierungen vornehmen (mit der open-source-Software Gretl) und verstehen die Möglichkeiten aber auch die Grenzen des methodischen Instrumentariums.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Methodische Grundlagen für Agrarökonomen (Vorlesung, Übung) *Inhalte*: Mathematische und statistische Analysemethoden, die Agrarökonomen im Rahmen des weiteren Studiums sowie im späteren Berufsleben verwenden.	6 SWS
Prüfung: Klausur (90 Minuten, Gewichtung 50%) und Hausarbeit (max. 30 Seiten, Gewichtung 50%) **Prüfungsanforderungen:** **Mathematische Grundlagen**: Matrizenalgebra, Differenzial- und Integralrechnung, jeweils auf agrarökonomische Fragestellungen (Marktgleichgewicht und komparativ-statische Analysen) angewandt. **Statistische Grundlagen**: Beschreibende Statistik (Mittelwerte, Streuungsmaße, Korrelations- und Konzentrationsmaße) und schließende Statistik (Hypothesentests, Mittelwertvergleiche, Verteilungen) sowie die Kleinstquadratmethode jeweils auf agrarökonomischen Fragestellungen (Beschreibung und Vergleiche von Märkten, Sektoren und Betrieben sowie Darstellung und Analyse von Trendentwicklungen) angewandt. Im Rahmen der Lehrveranstaltungen werden 5 Hausarbeiten mit jeweils rund 5 Seiten Umfang angefertigt.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Stephan von Cramon-Taubadel
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4
Maximale Studierendenzahl: 75	

Bemerkungen:
Vorlesung/Übung ist auf Englisch, wobei sämtliche Prüfungsleitungen auf Deutsch erbracht werden dürfen

Georg-August-Universität Göttingen **Modul B.Agr.0323: Nachhaltigkeit von Produktionssystemen** *English title: Sustainability of Production Systems*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen Pflanzen- und Nutztierproduktionssysteme ganzheitlich zu betrachten und die Umweltleistungen der Landwirtschaft, ihre Ziele und die Methoden einer nachhaltigen landwirtschaftlichen Entwicklung integrierend zu bewerten. Am Beispiel des Umweltgutes „Wasser" verstehen die Studierenden Nutzungssysteme im Zeichen des Klimawandels zu erörtern und können die erlernten Kenntnisse auf andere Bereich übertragen. Zielkonflikte zwischen Ökologie und Ökonomie werden im Dialog herausgearbeitet und Lösungsansätze zu ihrer Überwindung diskutiert. Dabei lernen die Studierenden fachbezogene Positionen zu formulieren und zu verteidigen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Nachhaltigkeit von Pflanzenproduktionssystemen (Vorlesung) *Inhalte*: Ressourcennutzung durch Pflanzenbestände, biologisch-regenerative Verfahren der Düngung, Nährstoffmobilisierung durch Pflanzen, Nährstoffeffizienz, Düngebedarfsermittlung, Kreislauf und Umweltwirkungen von Pflanzennährstoffen. Integration von Maßnahmen zur Herabsetzung der Schadenswahrscheinlichkeit im Bereich der Pflanzenpathologie, natürliche Regulationsmechanismen, Bedeutung der Heterogenität des Lebensraumes für Schad- und Nutzorganismen.	2 SWS
Lehrveranstaltung: Nachhaltigkeit von Tierproduktionssystemen (Vorlesung) *Inhalte*: Nachhaltige Ernährung: Futtermittel, Nährstoffumsetzung, Nutzung der tierischen Produkte durch den Menschen. Nachhaltige Ressourcennutzung: Biotische und abiotische Ressourcen (Fläche, Wasser, Boden, Luft, Reststoffverwertung und Energieerzeugung). Nachhaltigkeit von speziellen Produktionszweigen: Fleischerzeugung, Milcherzeugung, Eiererzeugung, Non-food Produkte (Wolle, Landschaftspflege).	2 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Präzise Kenntnisse der Nachhaltigkeit von Produktionssystemen von Nutzpflanzen, Pflanzenbau, Pflanzerernährung, Phytomedizin. Umfassendes Wissen über die Nachhaltigkeit von Produktionssystemen der Nutztiere, Tierhaltung, Tierphysiologie, Tierernährung, Energieflüsse in der Nahrungskette	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Stefan Siebert
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Agr.0324: Nutztierhaltung** *English title: Animal Husbandry*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen die theoretischen Hintergründe von Haltungssystemen landwirtschaftlicher Nutztiere und können mit diesen Informationen fachbezogene Probleme auf Praxisbetrieben erkennen und selbstständig lösen. Die Studierenden sind in der Lage die tiergerechte Gestaltung von Haltungssystemen landwirtschaftlicher Nutztiere wissenschaftlich fundiert umzusetzen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Nutztierhaltung (Vorlesung, Übung) *Inhalte*: Die Grundlagen der Haltung landwirtschaftlicher Nutztiere stehen im Mittelpunkt der Vorlesung. Dabei werden die Schwerpunkte "Haltungsbiologie" und "Nutztierhaltung" in Theorie und an praktischen Beispielen einzelner Tierarten einer näheren Betrachtung unterzogen. Der Schwerpunkt "Haltungsbiologie" umfasst ausgehend von den physiologischen Anpassungsreaktionen, der Konstitution und des Verhaltens der Tiere die Ableitung einer tiergerechten Gestaltung von Haltungssystemen. Möglichkeiten und Perspektiven der umweltgerechten Haltung von Nutztieren werden ebenfalls dargestellt.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Kenntnisse der Grundlagen der Haltungsbiologie und -technik landwirtschaftlicher Nutztiere; Fähigkeit der Darstellung von Produktionssystemen und -abläufen bei landwirtschaftlichen Nutztieren.	6 C

Zugangsvoraussetzungen: Kenntnisse aus den Grundlagen der Tierzucht, -ernährung und -haltung werden erwartet.	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. agr. Sabrina Elsholz
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 80	

Georg-August-Universität Göttingen **Modul B.Agr.0325: Nutztierzüchtung** *English title: Animal Breeding*	6 C 4 SWS
Lernziele/Kompetenzen: Aufbauend auf der im Modul B.Agr.0009: Grundlagen der Nutztierwissenschaften II erhaltenen Einführung in grundsätzliche Mechanismen der Tierzucht und Genetik sowie den Aufbau von Zuchtprogrammen, erwerben die Studierenden in diesem Modul vertiefte praxisorientierte Kenntnisse der Nutztierzüchtung in den relevanten Tierarten. Sie kennen die wesentlichen technologischen und organisatorischen Teilaspekte von Zuchtprogrammen und können die erfolgskritischen Prozessschritte erkennen und einschätzen. Die Studierenden sind in der Lage, die notwendigen züchterischen Maßnahmen im Fall einer Veränderung der Rahmenbedingungen abzuleiten. Dazu werden sie im Rahmen der detaillierten Analyse ausgewählter Zuchtprogramme auch mit grundsätzlichen züchterisch-statistischen Methoden, wie etwa der Veränderung von Allelfrequenzen, Ableitung der Ähnlichkeit unter Verwandten, Schätzung genetischer Varianzen, Herleitung genetischer Parameter und der Anwendung einfacher Selektionsindizes. Im Rahmen einer Pflichtexkursion wird ein Einblick in die auf niedersächsischen Betrieben zu findende Rassevielfalt gewonnen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Nutztierzüchtung (Vorlesung, Exkursion) *Inhalte*: • Grundlagen der quantitativen Genetik und der Populationsgenetik • Selektionsmethoden • Züchterisch bedeutende Merkmalskomplexe • Organisation der Tierzucht • Zuchtstrategien in den verschiedenen Nutztierarten • Anwendung grundsätzlicher Zuchtmethodiken • Anwendung eines Zuchtplanungsprogrammes	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Klausurinhalt: Kenntnisse der Grundlagen der quantitativen Genetik und der Populationsgenetik, grundlegende Kenntnisse der Selektionsmethoden, weiterführende Kenntnisse der züchterisch bedeutender Merkmalskomplexe, der Organisation der Tierzucht und von Zuchtstrategien in den verschiedenen Nutztierarten.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Nutztierwissenschaften II; Mathematik und Statistik
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Ahmad-Reza Sharifi
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	ab 4
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul B.Agr.0328: Ökotoxikologie und Umweltanalytik** *English title: Ecotoxicology and Environmental Analysis*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden sind mit den einschlägigen ökotoxikologischen und umweltanalytischen Konzepten und Methoden vertraut und können diese im Kontext der Agrarwissenschaften einordnen. Sie sind auf Basis der konzeptionellen Grundlagen befähigt Bewertungen durchzuführen und diese auf den Agrarraum anzuwenden. Im praktischen Teil erlernen die Studierenden ökotoxikologische sowie umweltanalytische Labortechniken und vertiefen damit die in der Vorlesung vermittelten theoretischen Lehrinhalte.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Ökotoxikologie und Umweltanalytik (Vorlesung, Übung) *Inhalte*: *I Umweltchemie*: Allgemeines (Entstehung der Umwelt, Umweltkompartimente, Anorganische und organische Xenobiotika; Chemischer Aufbau und molekulare Wechselwirkungsmechanismen umweltrelevanter nieder- und höhermolekularer synthetischer Verbindungen, u.a. Pflanzenschutzmittel, Schwermetalle, Schadstoffwirkung, sowie Festlegung, Verlagerung und Alternativen, wie Bioremediation, Analytik *II Toxikologie und spezielle Umweltmikrobiologie:* Toxizitätsbestimmung und -bewertung, Wege der Umweltchemikalien im Organismus, Wirkungsmechanismen auf zellulärer Ebene, Individuumpopulation, Bioakkumulation, biologische Untersuchungsverfahren und Testsysteme zur Bestimmung der Toxizität; mikrobielle Stoffumsetzung in der Umwelt, Metabolismus und Abbau von Fremdstoffen, bodenmikrobiologische Untersuchungsmethoden *Übungen zur Umweltanalytik und Ökotoxikologie im Agrarraum* photometrische und chromatographische Nachweisverfahren für Xenobiotika, wie Manganbestimmung, Trink- und Abwässer (Mikroplastik)-Analytik Toxikologische Bewertung und Mikrobiologie (Toxizitätsbestimmung mit Modellorganismen, u.a. Algen, Einzeller, immunchemische Nachweisverfahren von Toxinen am Beispiel von Bt-Toxin aus gentechnisch veränderten Pflanzen, Nachweis von Pharmazeutika in der Umwelt am Beispiel Antibiotika)	4 SWS
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsvorleistungen:** Teilnahme an Übung, Anfertigung von Versuchsprotokollen. **Prüfungsanforderungen:** Vertiefte Kenntnis und Verständnis der einschlägigen ökotoxikologischen und umweltanalytischen Konzepten und Methoden. Befähigung zur Bewertung der konzeptionellen Grundlagen. Weiterführende Kenntnisse der ökotoxikologischen sowie umweltanalytischen Labortechniken.	6 C

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**

keine	keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. nat. Susann Graupner
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** ab 5
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Agr.0329: Pflanzenbau und Pflanzenzüchtung** *English title: Crop Production and Plant Breeding*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen pflanzenbauliche Nutzungssysteme in ihrer Abhängigkeit von biotischen und abiotischen Faktoren kennen und können diese Kenntnisse auf die betriebliche Praxis übertragen. Pflanzenbauliche Konsequenzen aus dem sich abzeichnenden Klimawandel werden kritisch diskutiert, wobei die Studierenden lernen Positionen und Problemlösungen zu formulieren und argumentativ zu verteidigen. Die Studierenden kennen darüber hinaus den aktuellen Stand der Pflanzenzüchtung am Beispiel ausgewählter Fruchtarten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Pflanzenbau und Pflanzenzüchtung (Vorlesung) *Inhalte*: Teil Pflanzenbau: Prozesse der Ertragsbildung in Abhängigkeit von Umweltfaktoren, Einwirkung von abiotischen Stressfaktoren auf Nutzpflanzen, Einfluss von Klimawandel und Klimavariabilität auf Nutzpflanzenbestände, Pflanzenbauliche Anpassungsmaßnahmen an den Klimawandel Teil Pflanzenzüchtung: Wichtigste Zuchtziele und Grundzüge des Sortenwesens. Zuchtmethodische Grundlagen, allgemeine Methoden zur Züchtung von Klon-, Linien-, Populations- und Hybridsorten.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Basiswissen des Allgemeinen Pflanzenbaus, zum Einfluss abiotischer Faktoren auf Pflanzenwachstum, Entwicklung und Ertrag sowie genetische Grundlagen der Pflanzenzüchtung, der Zuchtziele und Zuchtmethodik.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Stefan Siebert
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul B.Agr.0330: Pflanzenernährung** *English title: Plant Nutrition – Nutrient Uptake and Transport*	6 C 4 SWS
Lernziele/Kompetenzen: Durch das Erlernen der grundlegenden Zusammenhänge der Nährstoffverfügbarkeit und Nährstoffaufnahme werden die Studierenden befähigt, Ursachen für Nährstoffversorgungsprobleme zu erkennen und kompetent Lösungswege zu erarbeiten. Sie sind in der Lage das Erlernte in die berufliche Praxis zu übertragen und Problemlösungsstrategien eigenständig zu erarbeiten. In den Laborübungen werden analytische Fertigkeiten erlernt, theoretisches Wissen angewendet und vertieft.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Pflanzenernährung (Vorlesung, Übung) *Inhalte*: Das Modul ist in einen Vorlesungsteil und praktische Laborübungen aufgeteilt. Im Vorlesungsteil werden grundlegende Mechanismen der Nährstoffverfügbarkeit, Nährstoffaufnahme und -verteilung in der Pflanze behandelt. Nährstoffverfügbarkeit: Hier wird besonders der Einfluss von Bodeneigenschaften, wie Bodenart, Austauschkapazität, organische Bodensubstanz, pH-Wert u.a. auf die Nährstoffverfügbarkeit betrachtet. Nährstoffaufnahme und -verteilung: Transport von Nährstoffen im Apoplast und durch die Membran, sowie im Xylem und Phloem. Einflussgrößen auf die Aufnahme (Temperatur, Sauerstoff, Bedarf, Ionenwechselwirkungen, pH, u.a.). Aufnahmeeffizienz und zugrunde liegende Mechanismen. In den Laborübungen analysieren die Studierenden Nähr- und Inhaltsstoffe in Böden und Pflanzenmaterial. Zudem wird der jeweils theoretische Hintergrund der Laboraufgabe besprochen. Hierbei werden die Kenntnisse über Nährstoffkreisläufe im Boden und die Funktionen von Nährstoffen in der Pflanze vertieft.	4 SWS
Prüfung: Klausur (90 Minuten, Gewichtung 70%) und praktische Prüfung (60 Minuten, Gewichtung 30%) **Prüfungsvorleistungen:** Erfolgreiche Teilnahme an den Laborübungen **Prüfungsanforderungen:** Grundlegende Zusammenhänge in den Bereichen Verfügbarkeit von Nährstoffen im Boden, Einflussgrößen hierauf und Messung. Nährstoffaufnahme und Transport in der Pflanze. Mechanismen der Nährstoffeffizienz verstehen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Tino Kreszies
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Agr.0333: Qualität tierischer Erzeugnisse** *English title: Quality of Food of Animal Origin*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden kennen Konzepte zum Qualitätsbegriff. Sie können wichtige Qualitätsmerkmale, Verfahren zu deren Erfassung und Zielkonflikte bei der Erzeugung und Verarbeitung tierischer Produkte erläutern. Die Studierenden können in ihrer beruflichen Tätigkeit relevante Informationen verarbeiten, Studienergebnisse einordnen und Problemlösungen erarbeiten. Durch die erworbenen Kenntnisse über die Beeinflussbarkeit der tierischen Produkte während der Wertschöpfungskette können sie mit Fachvertretern Informationen austauschen und bewerten. Die Studierenden können medienwirksam wichtige Erkenntnisse aus aktuellen wissenschaftlichen Veröffentlichungen zur Produktqualität tierischer Erzeugnisse und deren Bedeutung für Landwirt:innen, Wissenschaftler:innen, und Konsument:innen darstellen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Qualität tierischer Erzeugnisse (Vorlesung, Tutorium) *Inhalte*: Die Vorlesung umfasst v.a. die tierischen Lebensmittel Fleisch, Milch, Eier, Fisch und Honig. Dabei stehen Warenkunde, Merkmale und Verfahren zur Qualitätsbewertung inkl. Klassifizierung, relevante Produktionsfaktoren zur Beeinflussung von Qualitätsmerkmalen (z.B. Fütterung, Alter und Rasse von Nutztieren), Hygiene und Mikrobiologie tierischer Lebensmittel sowie aktuelle Verbrauchererwartungen und –präferenzen im Fokus. Die Vertiefung zu einem jener Themen erfolgt durch die Erstellung eines Vodcasts in Gruppenarbeit. Die dafür notwendigen Grundlagen zur richtigen Literaturauswahl sowie Medienkompetenzen zu Bild und Tonaufnahme, Postproduktion und der dafür zur Verfügung stehenden technischen Tools werden in Tutorien gelehrt.	4 SWS
Prüfung: Erstellung eines Vodcasts (15 Minuten) **Prüfungsvorleistungen:** Teilnahme an Tutorien ist verpflichtend. **Prüfungsanforderungen:** Erstellung eines Vodcasts (ca. 12-15 min) zur Vertiefung eines Themas der Vorlesung (=25% der Modulnote)	
Prüfung: Klausur (60 Minuten) **Prüfungsvorleistungen:** Teilnahme an Tutorien ist verpflichtend. **Prüfungsanforderungen:** Qualitätsdimensionen, Qualitätswahrnehmung, Bedeutung der tierischen Produktion und des Konsums tierischer Produkte; Wachstum und Entwicklung der Gewebe, Klassifizierung, Fleischbeschaffenheit und Bedeutung von Stoffwechselvorgängen, Milchqualität, Eiqualität, Nachweismethoden, Verarbeitungsprozesse, Einfluss der Ernährung auf die Produktqualität, Biologie der Keime, Stoffwechsel der Mikroorganismen, Lebensmittelhygiene.	

Eine Anmeldung zur Prüfung kann nur bei bestandener Prüfungsvorleistung erfolgen. Um das Modul zu bestehen, müssen der Vodcast (25%) und die Prüfung (75%) jeweils mindestens mit 4.0 bestanden werden.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Daniel Mörlein
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 120	

Georg-August-Universität Göttingen **Modul B.Agr.0336: Rechnungswesen und Controlling** *English title: Accounting and Controlling*	6 C (Anteil SK: 6 C) 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben das methodische Rüstzeug zur Schwachstellenanalyse in landwirtschaftlichen Betrieben. Sie sind in der Lage, im Einzelfall gangbare Vorgehensweisen zu identifizieren und anzuwenden, um aus dem vorhandenen Datenmaterial die bestmöglichen Informationen zu extrahieren. Sie erkennen, dass die Schwachstellenanalyse Ausgangspunkt für Planungsrechnungen ist.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Rechnungswesen und Controlling (Vorlesung) *Inhalte*: Im Mittelpunkt dieses Moduls stehen die Unternehmerfunktionen "Analyse" und "Kontrolle". Es werden Ansätze bzw. Methoden diskutiert, die es erlauben, die wirtschaftliche Situation von landwirtschaftlichen Betrieben zu analysieren. Zu den Lehrinhalten zählen: • Klassifikation des Rechnungswesens • Einführung in die doppelte Buchführung • Jahresabschlussanlyse inklusive Effizienzanalyse • Grundlagen der Taxation • Grundlagen der Steuerlehre • Leistungs-Kosten-Rechnung • Wirtschaftlichkeit ausgewählter Produktionsverfahren	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlagenkenntnisse zum Aufbau einer Bilanz, zum Aufbau einer Gewinn- und Verlustrechnung, zum Aufbau eines Betriebsabrechnungsbogens, zum Aufbau einer stufenweisen Fixkostendeckungsrechnung, zur Data-Envelopment-Analyse Determinanten der Wirtschaftlichkeit ausgewählter landwirtschaftlicher Produktionsverfahren	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Oliver Mußhoff
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 150	

Georg-August-Universität Göttingen **Modul B.Agr.0341: Ringvorlesung Ressourcenmanagement** *English title: Lecture Resourcemanagement*	6 C (Anteil SK: 6 C) 4 SWS

Lernziele/Kompetenzen: Verstehen und Anwenden aktueller Inhalte und Methoden, wie sie für den Schwerpunkt Ressourcenmanagement und zukunftsweisende Analysen und Bewertungen notwendig sind. Beurteilung aktueller Entwicklungen wie zum Beispiel der Folgen des Globalen Wandels für Kulturlandschaft und Agrarökosysteme und der Kompromisse zwischen Ökologie und Ökonomie im Sinne einer problemlösenden Anwendung des erlernten Wissens.	**Arbeitsaufwand:** Präsenzzeit: 40 Stunden Selbststudium: 140 Stunden

Lehrveranstaltung: Ringvorlesung Ressourcenmanagement (Seminar) *Inhalte*: Im Rahmen des Studienschwerpunkts Ressourcenmanagement können alle Kolloquien besucht werden, die in den Abteilungen und Fachgebieten Funktionelle Agrobiodiversität, Agrartechnik, Bioklimatologie, Bodenwissenschaften, Geographie, Forstpolitik und Naturschutz, Graslandwissenschaft, Agrarökonomie, Agrikulturchemie, Landwirtschaftsrecht, Tierphysiologie und Tierernährung, Pflanzenbau und Pflanzenzüchtung, Tierzucht und Haustiergenetik, Pflanzenbau und Tierproduktion in den Tropen, Pflanzenpathologie und Pflanzenschutz, Umwelt- und Ressourcenökonomik, und im Zentrum für Biodiversität und nachhaltige Landnutzung, hier insbesondere in der Sektion Naturschutz, Landwirtschaft und Umwelt, der Georg-August-Universität organisiert werden. Die Studierenden sollen sich für ihren Studienschwerpunkt eine Anzahl geeigneter Vorträge aussuchen. Damit erhalten sie einen Überblick über inhaltlich wie methodisch innovative Themen.	4 SWS
Prüfung: Hausarbeit (max. 25 Seiten) **Prüfungsvorleistungen:** Bescheinigung der Teilnahme an 20 Kolloquiumsterminen **Prüfungsanforderungen:** Erarbeitung von Hintergrundwissen zu verschieden Themen der Ökologie und der Biodiversitätsforschung. Im Rahmen der Ringvorlesung Ressourcenmanagemnt wird mit der Vielzahl der angebotenen Kolloquien ein Überblick über inhaltlich wie methodisch innovative Themen vermittelt. Teilnahme an mindestens 20 Kolloquiumsveranstaltungen, Ausarbeitung von mindestens 10 Kolloquiumsveranstaltungen als Hausarbeit, ca. 25 Seiten Gesamtlänge.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Westphal
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**

Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Agr.0344: Seminar Agrar- und Marktpolitik** *English title: Seminar on Agricultural Policy and Market Policy Analysis*	6 C (Anteil SK: 6 C) 4 SWS

Lernziele/Kompetenzen: Die Studierenden können im Studium erlernte ökonomische Konzepte und Methoden anwenden, um ausgewählte Themen aus dem Bereich Agrarpolitik und Agrarmärkte zu analysieren. Sie sind in der Lage, wissenschaftlich fundierte Urteile über agrarpolitische Maßnahmen und Entwicklungen auf Agrarmärkten abzuleiten. Die Studierenden sammeln Erfahrung mit der Präsentation von kurzen Fachvorträgen und dem Austausch von Informationen und Bewertungen mit Fachvertretern und Kollegen. Sie erlernen weitgehend selbständig eine schriftliche Seminararbeit zu verfassen sowie einen entsprechenden Fachvortrag einschließlich Diskussion durchzuführen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Seminar Agrar- und Marktpolitik (Seminar) *Inhalte*: Agrarpolitik und Agrarmärkte - Ausgewählte Fragestellungen im Brennpunkt Die Analyse von aktuellen agrar- und marktpolitischen Themen in der EU und in anderen Ländern anhand im Studium erlernter Konzepte und empirischer Methoden.	4 SWS
Prüfung: Präsentation, Referat oder Korreferat (ca. 20 Minuten, Gewichtung 50%) und Hausarbeit (max. 15 Seiten, Gewichtung 50%) **Prüfungsanforderungen:** Weiterführende Kenntnisse agrarpolitischer Maßnahmen in der EU und ausgewählten anderen Ländern und Entwicklungen auf nationalen und internationalen Agrarmärkten (Themenschwerpunkte werden jedes Jahr aktualisiert). Das Verfassen einer Seminararbeit (Literatursuche und -abgrenzung; Gliederung, korrekte Zitierweise, Erfüllung sonstiger formale Kriterien) und die Vorbereitung und Durchführung einer mündlichen Präsentation.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Stephan von Cramon-Taubadel
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 45	

Georg-August-Universität Göttingen **Modul B.Agr.0345: Spezielle Pflanzenzüchtung** *English title: Specialised Plant Breeding*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden können ihr Grundlagenwissen aus dem Pflanzenbau und der Pflanzenzüchtung auf aktuelle Probleme ausgewählter Nutzpflanzen anwenden und in ihre berufliche Praxis übertragen. Sie erlernen die Fähigkeit selbständig Literaturquellen zu sammeln, auszuwerten und zu interpretieren. Sie können ihr Wissen in Vorträgen und Diskussionen verständlich formulieren und in fachbezogenen Diskussionen argumentativ verteidigen.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
Lehrveranstaltung: Spezielle Pflanzenzüchtung (Vorlesung, Exkursion, Seminar) *Inhalte*: Die Studierenden erlernen Kenntnisse der Züchtung der wichtigsten einheimischen landwirtschaftlichen Kulturpflanzen. Exemplarisch werden auch gartenbauliche und tropische Kulturpflanzen, z.T. in Seminarvorträgen der Studierenden, behandelt. Es werden die Grundkenntnisse in der Zuchtmethodik vertieft und erweitert. Besonderen Wert wird gelegt auf aktuelle Zuchtziele. Dazu werden auch praktische Züchter zu Vorträgen mit Diskussion eingeladen. Zentrale Inhalte sind dabei die botanischen Grundlagen, die wichtigsten Zuchtziele sowie zuchttechnische Besonderheiten von landwirtschaftlich genutzten Kulturpflanzen.	4 SWS
Prüfung: Präsentation, Referat oder Korreferat (ca. 20 Minuten, Gewichtung 30%) und Klausur (90 Minuten, Gewichtung 70%) **Prüfungsanforderungen:** Profunde Kenntnisse der Züchtung der wichtigsten einheimischen landwirtschaftlichen Kulturpflanzen.	6 C

Zugangsvoraussetzungen: Kenntnisse aus den im Modul "Pflanzenbau" und "Pflanzenzüchtung" behandelten Themenbereichen werden erwartet.	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Antje Schierholt
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Modul B.Agr.0346: Spezielle Phytomedizin** *English title: Specialised Phytomedicine*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden verfügen über taxonomische Grundkenntnisse zur Erkennung von Schadursachen. Sie wissen um die Vorgehensweise bei der Diagnostik von Pflanzenerkrankungen und sind in der Lage eigenständige Diagnosen zu erstellen. Die Studierenden können auf Grundlage des Erlernten mögliche protektive und kurative Maßnahmen zum Bestandesschutz ableiten. Das Modul ist Bestandteil des Sachkundenachweises nach der Bundessachkundeverordnung für die Anwendung chemischer Pflanzenschutzmittel.	**Arbeitsaufwand:** Präsenzzeit: 62 Stunden Selbststudium: 118 Stunden
Lehrveranstaltung: Spezielle Phytomedizin (Praktikum, Vorlesung, Exkursion) *Inhalte*: In dem Modul "Spezielle Phytomedizin" werden die an Kulturpflanzen auftretenden, wichtigsten Schadorganismen (Viren, Bakterien, Pilze, Nematoden, Milben, Insekten, u.a.) anhand von befallenen Pflanzenproben eingehend behandelt. Hierzu werden mikroskopische Untersuchungen im Kursraum durchgeführt, ergänzt durch Feldbegehungen zur Diagnose von Pathogenen und Erfassung von Schädlingen und ihrer natürlichen Feinde in den Kulturpflanzenbeständen. Neben der Erkennung und Diagnose der Schadorganismen und der typischen Befallssymptome stehen die wirtschaftliche Bedeutung, die Biologie, die Prognose und die verschiedenen Möglichkeiten der Bekämpfung, insbesondere unter Beachtung von Bekämpfungs- und Schadensschwellen, im Vordergrund. Zur Veranstaltung wird eine halbtägige Exkursion zu Einrichtungen des amtlichen Pflanzenschutzes angeboten	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Dezidierte Kenntnisse von Taxonomie, Lebenszyklen, Schadbildern, diagnostischen Merkmale und Bekämpfungsmöglichkeiten der Schaderreger	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Birger Koopmann
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 75	

Bemerkungen:

Änderung MV (von Tiedemann) 30.05.2018

Georg-August-Universität Göttingen **Modul B.Agr.0347: Stoffhaushalt des ländlichen Raumes** *English title: Material Household of Rural Areas*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden besitzen Kompetenzen in der Einschätzung der gesellschaftlichen Interessen zur Ver- und Entsorgungssituation kommunaler Verbände in den Sektoren "Wasser", "Abwasser", "Kompost" und "Energie" im ländlichen Raum auf den naturwissenschaftlichen Grundlagen. Sie sind in der Lage ihre Kenntnisse auf praktische Problemstellungen zu übertragen und diese in ihrer beruflichen Tätigkeit anzuwenden. Sie können sich fachlich mit Laien und Fachleuten austauschen und in Diskussionen ihre Standpunkte wissenschaftlich fundiert verteidigen.	**Arbeitsaufwand:** Präsenzzeit: 96 Stunden Selbststudium: 84 Stunden
Lehrveranstaltung: Stoffhaushalt des ländlichen Raumes (Blockveranstaltung, Vorlesung, Exkursion) *Inhalte*: Trinkwasser: Typen, Höffigkeit, Erschließung, Gewinnung, ökoingenieurmäßige Sanierung, Sicherung und Lenkung von Schutzgebieten Abwasser: Klärtechniken und -systeme, Klärwasser und Klärschlammrecycling Festabfälle: Deponiesysteme, Kompostierung, Trennsysteme, biologische und thermische Verwertung Energie aus der Landwirtschaft: Biogasverfahren, Einsatzstoffe, Anbau, Nährstoffkreislauf; Anbau von schnellwachsenden Hölzern und anderen "Energie-"Pflanzen Bodenschutz: Auswirkungen der Kreislaufwirtschaft auf Nähr- und Schadstoffhaushalt und Bodenschutzparameter Der Lehrinhalt wird durch die Besichtigung von Wasserwerken, Klärwerken, Kompostwerken, Energieerzeugungsanlagen (auf der Basis landwirtschaftlichen Rohstoffe) veranschaulicht. Eine 2-Tagesexkurison in den norddeutschen bzw. mitteldeutschen Raum (alternierend) schließt die Vorlesung ab.	
Prüfung: Mündliche Prüfung (ca. 30 Minuten, Gewichtung 60%) und Hausarbeit (max. 10 Seiten, Gewichtung 40%) **Prüfungsanforderungen:** Basisprozesse der Klärtechniken, der Biogasproduktion, des Anbaus NAWARO, der Trinkwassergewinnung und des Boden- und Grundwasserschutzes.	6 C

Zugangsvoraussetzungen: Kenntnisse aus den im Modul "Bodenkunde und Geoökologie" behandelten Themenbereichen werden erwartet.	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Peter Gernandt

Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Agr.0348: Strategisches Management in der Agrar- und Ernährungswirtschaft** *English title: Strategic Management in Agribusiness*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden kennen die Merkmale strategischer Entscheidungen und können die Bedeutung von strategischem Management in der der Agrar- und Ernährungswirtschaft beschreiben. Sie können Methoden zur Lösung strategischer Planungsprobleme in Betrieben der Agrar- und Ernährungswirtschaft erklären. Sie können anhand von Fallbeispielen die strategische Position eines Unternehmens bestimmen sowie die geeigneten Methoden identifizieren und anwenden, um eine unternehmerische Zielsetzung und eine passende Strategie zu entwickeln. Sie werden dadurch in die Lage versetzt Lösungen für schwer strukturierbare, komplexe strategische Problemstellungen im Agribusiness zu entwickeln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Strategisches Management in der Agrar- und Ernährungswirtschaft (Vorlesung, Übung) *Inhalte*: Das Modul vermittelt die Grundzüge der strategischen Unternehmensplanung in der Agrar- und Ernährungswirtschaft. Im Mittelpunkt steht die Einübung ausgewählter Techniken zur Klassifizierung und Lösung komplexer strategischer Entscheidungsprobleme in Unternehmen der Agrar- und Ernährungswirtschaft.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Folgende Anforderungen sind notwendig: 1. Darstellung von Geschäftsmodellen und Wettbewerbsstrategien sowie der Merkmale strategischer Entscheidungen in Unternehmen der Agrar- und Ernährungswirtschaft. 2. Kenntnis und Anwendung der Methoden zur Analyse strategischer Problemstellungen: Umfeldanalyse (u.a. Szenario-Analyse; Wettbewerbskräfteanalyse; Branchenlebenszyklusmodell), Analyse strategischer Fähigkeiten (ressourcenbasierter Ansatz im strategischen Management; Kernkompetenzen) und Unternehmensstrategien (Diversifikation; Portfolio-Modelle; Internationalisierung).	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Silke Hüttel
Angebotshäufigkeit:	**Dauer:**

jedes Wintersemester	1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 200	

Georg-August-Universität Göttingen **Modul B.Agr.0349: Tierernährung** *English title: Animal Nutrition*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden verfügen über grundlegendes Wissen für die tätigkeitsbezogene Anwendung bei der Erstellung von Futterrationen für Nutztiere. Sie besitzen die Fähigkeiten zur Bewertung und Interpretation von Futterrationen und sind in der Lage auf einem wissenschaftlichen Niveau, Informationen über etwaige Problemlösungen auszutauschen. Durch praktische Tätigkeiten (Praktikum Futtermittelanalyse) wird ihre Urteilsfähigkeit fundiert weiterentwickelt. Sie können mit Optimierungsprogrammen zur Energie- und Nährstoffversorgung von Nutztieren umgehen und diese Fähigkeiten in der Praxis zur Anwendung bringen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Tierernährung (Praktikum, Vorlesung) *Inhalte*: Fütterungsziele und ernährungsphysiologische Bedingungen bei der Umsetzung einer bedarfsangepassten und damit umwelt- und produktorientierten Energie- und Nährstoffversorgung von Nutztieren: Rinder, Schafe und Ziegen, Schweine, Geflügel, Pferde und Fische, Kaninchen. Das verwendbare Futtermittelspektrum sowie spezifische Qualitätsanforderungen werden in typischen Rationsgestaltungen berücksichtigt. Hierzu stellen insbesondere auch Übungen zur Optimierung von Futtermischungen/Rationen wesentliche Ergänzungen dar. Die individuelle Durchführung eines Blockpraktikums zur Futtermittelanalytik ist fester Bestandteil des Moduls und sichert grundlegende Einsichten bei der Bewertung von Futtermitteluntersuchungsergebnissen.	4 SWS
Prüfung: Mündliche Prüfung (ca. 30 Minuten, Gewichtung 80%) und Projektarbeit (max. 10 Seiten, Gewichtung 20%) **Prüfungsvorleistungen:** Laborpraktikum Futtermittelanalytik **Prüfungsanforderungen:** Tierartabhängige Grundsätze bei der Ernährung/Fütterung von Rindern (Kalb, Jungrind, Milchkuh, Mastrind), Schafen und Ziegen, Schweinen (Sau, Ferkel, Mastschwein, Jungsau), Geflügel (Legehennen, Mastgeflügel, Elterntiere), Pferden, Fischen; Kaninchen, Eckpunkte des Futtermitteleinsatzes (Futterwert, Futtermittelrecht) und der Verwendung von Futterzusatzstoffen.	6 C

Zugangsvoraussetzungen: B.Agr.0008	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** N. N.
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 72	

Georg-August-Universität Göttingen **Modul B.Agr.0350: Tierhygiene, Ethologie und Tierschutz** *English title: Animal Hygiene, Ethology and Animal Welfare*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden kennen die grundlegenden Zusammenhänge für das Verständnis von modernen Konzepten staatlicher und freiwilliger Programme in der Tierseuchenbekämpfung sowie für Qualitätssicherungssysteme in Hygieneprogrammen. Sie können ihr Wissen in der Praxis problemlösend anwenden und zielorientiert weiterentwickeln. Sie lernen fachbezogen Positionen kennen und können diese argumentativ in Diskussionen bewerten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Tierhygiene, Ethologie und Tierschutz (Vorlesung) *Inhalte*: Das Modul behandelt die spezifischen Charakteristika von Mikroorganismen (Parasiten, Bakterien, Pilze, Viren, Prionen), die bei landwirtschaftlichen Nutztieren als Infektionserreger von Bedeutung sind. Neben der allgemeinen Infektions- und Seuchenlehre, werden die Funktionskreise zwischen Mikroorganismen, Nutztieren, Personen und der Umwelt aufgezeigt. Neben einer Einführung in die Immunologie und Abwehrsysteme der Nutztierorganismen werden auch ausgewählte und praxisrelevante Infektionskrankheiten vorgestellt, einschließlich der Möglichkeiten zur Diagnose, Therapie und Prophylaxe. Das Modul vermittelt auch Kenntnisse einer zeitgemäßen Labordiagnostik, in der heute molekularbiologische, immunologische und mikrobiologische Techniken zum Erreger- und Schadstoffnachweis im Vordergrund stehen. Es werden die Grundlagen des Verhaltens von Nutztieren unter besonderer Berücksichtigung endogener und exogener Einflussfaktoren vermittelt (Reizwahrnehmung, Bewusstsein, Verhaltensgenetik, Kommunikation, Motivation, Lernen). Einen Schwerpunkt bildet die Diskussion der Auswirkung von Haltungssystemen auf die Verhaltensausprägung. Verhaltensabweichungen sowie physiologische Reaktionen werden als Indikatoren für tiergerechte Haltungssysteme erörtert. Die Bedeutung der Mensch-Tier-Beziehung wird einbezogen.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Umfassende Kenntnisse der Biologie und Pathogenese von Infektionserregern, des Abwehrsysteme von Wirbeltieren, von Nachweismethoden und Prophylaxe bei Infektionskrankheiten, Etablierung von Hygieneprogrammen, abiotischen Faktoren, Reinigung, Desinfektion, Entwesung, Tierkörperbeseitigung, Umwelthygiene, Grundlagen des Verhaltens, ethologische Funktionskreise, Verhalten und tiergerechte Haltungssysteme, Tierschutz	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. med. vet. Rafael Hernán Mateus-Vargas

Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 60	

Georg-August-Universität Göttingen **Modul B.Agr.0351: Übung zur Nutzpflanzenkunde** *English title: Exercises in Crop Science and Agronomy*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden werden in die Lage versetzt, durch Beobachtungen und Messungen die Pflanzenentwicklung sowie Wachstum und Ertragsbildung unterschiedlicher Feldfrüchte zu charakterisieren. Anhand der BBCH-Skala werden die Studierenden angeleitet, die Entwicklungsstadien von Feldfrüchten eindeutig zu identifizieren. Im Verlauf der Anbauperiode werden die Blatt- und Triebzahl sowie die Ertragskomponenten erfasst. Die Studierenden lernen Stresssymptome zu erkennen, zu differenzieren sowie durch Messungen zu belegen. Die Studierenden lernen wichtige Kenngrößen wie Blattfläche, Wuchshöhe, sowie Biomasse auf Pflanzen- und Bestandesebene zu erheben. Die Spatendiagnose vermittelt den Studierenden die Möglichkeit, im Freiland mit einfacher Ausstattung biologische, chemische und physikalische Parameter zu erfassen, die die Bodengesundheit charakterisieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Übungen zur Nutzpflanzenkunde (Übung) *Inhalte*: Kennenlernen landwirtschaftlicher Nutzpflanzen durch Studium am lebenden Objekt, Kennenlernen relevanter Mess- und Boniturmethoden zur Charakterisierung von Einzelpflanzen und Pflanzenbeständen. Einsatz des Blattflächenmessgerätes. Ansprache der Entwicklungsstadien von Feldfrüchten anhand der BBCH-Skala. Messung von Bestandeshöhe, Biomassekomponenten, Bestandestemperatur, Bodenfeuchte sowie Lichteinfall in den Bestand. Anwendung der Spatendiagnose zur Ansprache der Bodenqualität. Die Veranstaltung wird auf den zur Fakultät gehörenden Versuchsflächen auf dem Reinshof sowie in Deppoldshausen durchgeführt.	4 SWS
Prüfung: Klausur (50%, ca. 45 Minuten), Protokolle (50%, max. 10 Seiten) **Prüfungsvorleistungen:** Regelmäßige Teilnahme an den Übungen **Prüfungsanforderungen:** Grundkenntnisse des Pflanzenbaus, der Nutzpflanzenkunde und des Feldversuchswesens. Das Erstellen von Protokollen und Datentabellen zu den selbst vorgenommenen Messungen und Beobachtungen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Stefan Siebert
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

14	

Georg-August-Universität Göttingen **Modul B.Agr.0352: Übungen zur Produktqualität pflanzlicher Erzeugnisse** *English title: Exercises on Quality of Temperate, Tropical and Subtropical Crops*	6 C

Lernziele/Kompetenzen: Die Studierenden erwerben instrumentelle (analytische) Kompetenzen. Sie wissen, wie analytisch ermittelte Daten unter Zuhilfenahme wissenschaftlicher Literatur interpretiert und im Kontext von Ökonomie und Verbrauchererwartungen bewertet werden. Weiterhin sind sie befähigt im Team zu arbeiten und sich gegenseitig über Informationen, Probleme und Lösungen auszutauschen.	**Arbeitsaufwand:** Präsenzzeit: 40 Stunden Selbststudium: 140 Stunden

Lehrveranstaltung: Übungen zur Produktqualität pflanzlicher Erzeugnisse (Blockveranstaltung, Übung) *Inhalte*: Übungen zu ausgewählten Qualitätsmerkmalen von Getreide, Kartoffeln, Obst und Gemüse: Stärke- und Proteinqualität; rheologische Eigenschaften; Teig- und Backeigenschaften von Getreide; Sensorik von Backwaren; Koch- und Frittiereigenschaften bei Kartoffeln; Konsumentenakzeptanz von Kartoffeln, Vermarktungseigenschaften von Obst und Gemüse; Texturanalyse, Ermittlung des Reifegrades; innere Qualitätsmerkmale von Obst und Gemüse sowie daraus hergestellten Säften (u.a. Zucker/Säureverhältnis, Ethanol in Fruchtsaft), Sensorik von Obst- und Gemüsesäften.	
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsvorleistungen:** Teilnahme an den experimentellen Arbeiten im Labor verpflichtend **Prüfungsanforderungen:** Analytische Kenntnisse in der aktiven Durchführung aller Übungen Beschreibung der durchgeführten Übungen, Datenauswertung und Interpretation unter Verwendung wissenschaftlicher Literatur in Kontexte des Lebensmittelrechts, der Verbrauchererwartungen und/oder der Ökonomie.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Modul Qualität und Nacherntetechnologie oder vergleichbare Module/Kenntnisse
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Susanne Neugart
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 12	

Georg-August-Universität Göttingen **Modul B.Agr.0354: Unternehmensplanung** *English title: Quantitative Methods in Corporate Planning*	6 C (Anteil SK: 6 C) 6 SWS

Lernziele/Kompetenzen: Die Studierenden erwerben das methodische Rüstzeug zur Lösung praktischer, quantitativ handhabbarer Planungsprobleme in landwirtschaftlichen Betrieben. Sie sind in der Lage, das sich im Einzelfall stellende Problem zu identifizieren und die zur Problemlösung geeigneten Techniken zu identifizieren und anzuwenden. Sie werden dadurch in die Lage versetzt, auch komplexere betriebliche Probleme zu durchdringen und zu lösen.	**Arbeitsaufwand:** Präsenzzeit: 80 Stunden Selbststudium: 100 Stunden

Lehrveranstaltung: Unternehmensplanung (Vorlesung) *Inhalte*: Im Mittelpunkt dieses Moduls steht die Unternehmerfunktion "Planung". Es werden ausgewählte Techniken zur Lösung gut strukturierter und quantitativ handhabbarer Planungsprobleme in landwirtschaftlichen Betrieben diskutiert. Zu den Lehrinhalten zählen: • Überblick über betriebliche Planungsmethoden • Gestaltung von Produktionsverfahren • Gestaltung des Produktionsprogramms inkl. lineare Programmierung • Angewandte Investitionsplanung • Netzplantechnik	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Prinzipien und Grundkenntnisse in: • Produktionstheorie • Linearer Programmierung • Rentabilitätskriterien von Investitionen • MS-EXCEL-Grundfertigkeiten	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Oliver Mußhoff
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 150	

Georg-August-Universität Göttingen **Modul B.Agr.0355: Vegetationskunde** *English title: Vegetation Science*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen wichtige Pflanzenarten und Pflanzengesellschaften von Äckern und Grünland kennen und können diese mit verschiedenen Techniken der Bestimmung identifizieren. Sie sind in der Lage mit Hilfe verschiedener Methoden eine Bewertung unterschiedlicher Standorte anhand der Vegetation durchzuführen. Sie entwickeln ein analytisches Verständnis für Zusammenhänge zwischen Standort, Bewirtschaftung und Vegetation auf Acker- und Grünland und können dieses auf ihre berufliche Praxis übertragen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vegetationskunde (Vorlesung, Übung) *Inhalte*: Entstehung und Besonderheiten der Acker- und Graslandvegetation, Herkunft der Acker- und Graslandpflanzen, Ökologie, Nutzwert, Schadwirkungen verbreiteter Ackerunkräuter und Graslandarten, Elemente der Population und Populationsentwicklung, Ausbreitungsstrategien, Prinzipien des Zusammenlebens der Pflanzenarten, Konkurrenz, Koexistenz, Diversität, Grundzüge der beschreibenden Vegetationskunde, Ackerunkrautgesellschaften, Graslandgesellschaften. Methoden der Vegetationskartierung, herbologische und graslandwirtschaftliche Forschungsmethoden, ökologische, floristische und agronomische Bewertung verschiedener Pflanzenbestände des Ackers und des Graslandes, Indikatoren für Standort und Nutzung, Feldmethoden zur Beurteilung der Schadwirkung von Ackerunkräutern sowie zur Bewertung von Frischfutter, Heu und Silagen des Graslandes, Erarbeitung von Nutzungsoptionen bzw. Pflegeplänen. Erstellung eines Herbars mit 50 höheren Pflanzenarten des Acker- und Grünlands.	4 SWS
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsvorleistungen:** Erstellung eines Herbars **Prüfungsanforderungen:** Vorlage eines im Rahmen des Moduls erstellten Herbars, Beherrschung der Methoden und Inhalte der Vegetationskunde in der Agrarlandschaft Umfassende Kenntnisse und sachgerechte Beherrschung bzw. Anwendung der theoretischen und methodischen Inhalte des Moduls.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Johannes Isselstein
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 35	

Georg-August-Universität Göttingen **Modul B.Agr.0356: Verfahrenstechnik in der Nutztierhaltung** *English title: Animal Husbandry Systems*	6 C 4 SWS
Lernziele/Kompetenzen: Studierende erlernen verfahrenstechnische Fachinformationen aus verschiedenen Teilbereichen des Studiums auf die Nutztierhaltung zu übertragen und in komplexe Fragestellungen zu integrieren. Sie können fachbezogene Positionen und Problemlösungen formulieren und diese kompetent mit Fachleuten und Laien diskutieren. Sie sind in der Lage Informationen, Ideen und Lösungen austauschen und selbständig weiterzuentwickeln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Verfahrenstechnik in der Nutztierhaltung (Vorlesung, Seminar) *Inhalte*: Im Rahmen dieses Moduls werden die Produktionssysteme der Nutztierhaltung dargestellt und die Systemwahl analysiert. Neben den Teilprozessen der Tierproduktion (Futterbereitstellung, Klimagestaltung, Entmistung, Reststoffverwertung, Abluftbehandlung und bioenergetische Verwertung) werden auch Verfahren der vor- und nachgelagerten Bereiche behandelt. In ausgewählten Projekten werden diese Prozesse vertiefend, multifaktoriell bewertet.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Vertiefte Kenntnisse des Stoffgebiets: Gestaltung und Bewertung verfahrenstechnischer Prozesse in der Nutztierhaltung, Klimatechnik, Verwertung biogener Reststoffe.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Agr.0016
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. agr. Sabrina Elsholz
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 80	

Georg-August-Universität Göttingen **Modul B.Agr.0357: Einführung in GIS** *English title: Introduction to GIS*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden kennen die grundlegenden Funktionen eines Geographischen Informationssystems (GIS) welches sich mit der Erfassung, Verwaltung, Analyse und Präsentation von raumbezogenen Daten beschäftigt. Die Studierenden können kleinere praktische GIS-Projekte durchführen und sind befähigt die Möglichkeiten die GIS bietet zu verstehen und in ihre zukünftige Arbeit zu integrieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Einfürung in GIS (Vorlesung, Übung) *Inhalte*: Einführung in Geographische Informationssysteme – Definitionen, Anwendungsbereiche und Trends; GIS Datenformate (Vektor / Raster); Arbeiten mit Attributtabellen; Projektionen und Koordinatensysteme; Digitalisierungsarbeiten; GPS-gestützte Geländearbeit; Erstellung und Verarbeitung von Drohnenaufnahmen; Recherche und Verarbeitung von Geodaten (OpenData); Geodatenanalyse; Satellitenbilddaten – Recherche, Verarbeitung und Analyse; Darstellung von Geodaten und Export zur Weiternutzung in anderen Anwendungen; in den Übungen wird mit freier Software auf dem eigenen Rechner (Notebook) gearbeitet	4 SWS
Prüfung: Hausarbeit (max. 20 Seiten) **Prüfungsanforderungen:** Das GIS-Abschlussprojekt (Hausarbeit) besteht aus einem schriftlichen Projektbericht (max. 20 Seiten), in dem die Verarbeitung von Geodaten mittels eines GIS entsprechend der Aufgabenstellung beschrieben wird und die Ergebnisse in Form von Karten dargestellt werden . Das Ziel des individuellen Abschlussprojektes liegt in das Einüben und Vertiefung von erlernten konzeptionellen und technischen GIS-Fähigkeiten.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Stefan Siebert
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 14	

Georg-August-Universität Göttingen **Modul B.Agr.0358: Übungen zu Anatomie und Physiologie der Nutztiere** *English title: Practical Course in Anatomy and Physiology of Livestock*	6 C 12 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben in diesem Modul instrumentelle und systematische Kompetenz in den Bereichen Molekularbiologie (Isolierung von DNA aus Blut, Gewebe und Lebensmitteln, Gelelektropherese, Auswertung von Agarosegelen, Mikrobiologie (Anfertigung von Ausstrichen, Systematik, Bestimmung von Bakterien), Sektion (Sektion landwirtschaftlichen Nutztieres, Geflügelsektion), Skelett und Muskulatur (Aufbau und Funktion des Bewegungsapparats bei Haussäugetieren), Zellbiologie (Anfertigung von Blutausstrichen, Bestimmung von Blutzellen, mikroskopische Untersuchungen tierischer und pflanzlicher Zellen während der Teilung), Atmung und Kreislauf (Aufbau und Funktion des Herzens, Untersuchung von Organpräparaten), Niere und Leber (Anatomie und Physiologie wichtiger Organsysteme), männliche und weibliche Geschlechtsorgane (Untersuchung von Organpräparaten, Beschreibung der Organfunktion, hormonelle Steuerung der Sexualfunktion), Sektion (Komplettsektion eines landwirtschaftlichen Nutztieres (Untersuchung der Bauchhöhle und Organe, Kopf, ZNS, Kehlkopf).	**Arbeitsaufwand:** Präsenzzeit: 168 Stunden Selbststudium: 12 Stunden
Lehrveranstaltung: Übungen zu Anatomie und Physiologie der Nutztiere (Übung) *Inhalte*: Molekularbiologie (Isolierung von DNA aus Blut, Gewebe und Lebensmitteln, Gelelektropherese, Auswertung von Agarosegelen, Mikrobiologie (Anfertigung von Ausstrichen, Systematik, Bestimmung von Bakterien), Sektion (Sektion landwirtschaftlichen Nutztieres), Skelett und Muskulatur (Aufbau und Funktion des Bewegungsapparats bei Haussäugetieren), Zellbiologie (Anfertigung von Blutausstrichen, Bestimmung der Blutzellen, mikroskopische Untersuchungen tierischer und pflanzlicher Zellen während der Teilung), Atmung und Kreislauf (Aufbau und Funktion des Herzens, Untersuchung von Organpräparaten), Niere und Leber (Anatomie und Physiologie wichtiger Organsysteme), männliche und weibliche Geschlechtsorgane (Untersuchung von Organpräparaten, Beschreibung der Organfunktion, hormonelle Steuerung der Sexualfunktion), Sektion (Komplettsektion eines landwirtschaftlichen Nutztieres (Untersuchung der Bauchhöhle und Organe, Kopf, ZNS, Kehlkopf), Geflügelsektion.	12 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlagenkenntnisse in folgenden Bereichen: Isolierung von DNA aus Blut, Gewebe und Lebensmitteln, Gelelektropherese, Auswertung von Agarosegelen, Anfertigung von Ausstrichen, Systematik, Bestimmung von Bakterien, Aufbau und Funktion des Bewegungsapparats bei Haussäugetieren, Anfertigung von Blutausstrichen, Bestimmung von Blutzellen, mikroskopische Untersuchungen tierischer und pflanzlicher Zellen während der Teilung, Aufbau und Funktion des Herzens, Untersuchung von Organpräparaten (Lunge, Leber, Niere, Magen, Euter), Anatomie und Physiologie wichtiger Organsysteme, männliche	6 C

und weibliche Geschlechtsorgane, hormonelle Steuerung der Sexualfunktion, Komplettsektion eines landwirtschaftlichen Nutztieres, Untersuchung der Bauchhöhle und Organe, Kopf, ZNS, Kehlkopf, Geflügelsektion.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Dr. Bertram Brenig
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 400	

Georg-August-Universität Göttingen **Modul B.Agr.0363: Düngemittel und ihre Anwendung** *English title: Fertilizer and their Application*	6 C 4 SWS
Lernziele/Kompetenzen: Den Studierenden wird insbesondere die Kompetenz zur pflanzenbaulich aber auch ökonomischen Beurteilung von Vor- und Nachteilen einzelner Düngemittel für spezifische Standortbedingungen und Kulturarten vermittelt. Darüber hinaus sollen sie die Fähigkeit zum Abschätzen mittelfristiger Entwicklungen auf dem Gebiet der Düngebedarfsermittlung und dem Düngemittelmarkt (Ressourcenverknappung) und daraus zu ziehende mögliche betriebswirtschaftliche Konsequenzen entwickelt werden. Der Studierende soll zur Beurteilung der Vor- und Nachteile von Prinzipien unterschiedlicher Formen des ökologischen Landbaus befähigt werden.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
Lehrveranstaltung: Düngemittel und ihre Anwendung (Vorlesung, Exkursion, Seminar) *Inhalte*: In dem Module werden die chemischen, technologischen und anwendungstechnischen Eigenschaften insbesondere von N,P,K, S, Mehrnährstoffdüngern, Mikronährstoffdüngern und organischen Düngern behandelt. Ein weiterer Gegenstand des Moduls ist die Nutzung und spezifische Wirkungsweise der besprochenen Düngemittel bei unterschiedlichen Standortbedingungen, Kulturarten und Fruchtfolgen. Hierbei werden Umsetzungen im Boden besprochen. Es werden Ergebnisse von Dauerdüngungsversuchen dargestellt und lang- und mittelfristige Entwicklungen auf dem Düngemittelmarkt erörtert. Darüber hinaus werden Kenntnisse über die Prinzipien der Düngebedarfsermittlung, über die Düngungsverordnung und die Düngemittelgesetzgebung vermittelt. Es wird auf Besonderheiten in den einzelnen Formen des ökologischen Landbaus eingegangen.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Kenntnis der Nährstoffdynamik in Böden und deren Bedeutung für die Düngung, Kenntnis der wichtigsten Methoden der Boden- und Pflanzenanalyse und der Düngebedarfsermittlung und ihrer Anwendung; Kenntnisse der wichtigsten mineralischen und organischen Düngemittel, ihrer Herstellung/Entstehung, Eigenschaften, ihrer fachgerechten Anwendung und der dabei auftretenden potenziellen Probleme. Kenntnisse der Ziele und der rechtlichen Rahmenbedingungen der Düngung und des Einflusses der Düngung auf die Produktqualität.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Klaus Dittert
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Agr.0364: Pflanzenschutz** *English title: Plant Protection*	6 C 4 SWS
Lernziele/Kompetenzen: Kenntnisse der wichtigsten Verfahren im Pflanzenschutz, deren Einsatzbereiche und Wirkungsweise; Kenntnisse zur Wirkungsweise von Pflanzenschutzmitteln und deren Anwendungsregelungen; vorbeugende, gezielte und alternative Pflanzenschutzverfahren Das Modul ist Bestandteil des besonderen Modulkatalogs, der für den Erwerb des amtlichen Sachkundenachweises im Pflanzenschutz gemäß §§ 10, 20 PflSchG erfüllt sein muß.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Pflanzenschutz (Vorlesung, Exkursion, Seminar) *Inhalte*: Allgem. Begriffe; gute fachliche Praxis und integrierter Pflanzenschutz; Vorteile und Risiken; wichtige rechtliche Regelungen im Pflanzenschutz; acker- und pflanzenbauliche Maßnahmen zur Herabsetzung der Schadenswahrscheinlichkeit; Wirkungsweise und Einsatzbereiche wichtiger Pflanzenschutzmittelwirkstoffe; gezielter Einsatz von PSM; integrierte Schädlingsbekämpfung; biologische und biotechnische Verfahren; gezielter Einsatz von Herbiziden, Bodenbearbeitung, Entscheidungshilfen, nicht-chemische Unkrautbekämpfung; Einsatz von Biotechnologie im Pflanzenschutz.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Erfolgreiche Teilname am Seminar **Prüfungsanforderungen:** Gute Kenntnisse der Pflanzenschutzverfahren, insbesondere des Integrierten Pflanzenschutzes, sowie der Wirkung und Anwendung von chemischen und nicht-chemischen Pflanzenschutzmaßnahmen; gute Kenntnisse der Guten fachlichen Praxis und der rechtlichen Regelungen im Pflanzenschutz.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Andreas von Tiedemann
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 60	

Georg-August-Universität Göttingen **Modul B.Agr.0365: Ökologischer Pflanzenbau** *English title: Ecological Crop Production*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen die speziellen pflanzenbaulichen Eigenheiten des ökologischen Landbaus kennen. Sie sind in der Lage, Unterschiede zu anderen Landbaussystemen zu erfassen. Ferner sind sie imstande, Empfehlungen zur Umstellung auf den ökologischen Landbau abzugeben.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Ökologischer Pflanzenbau (Vorlesung, Exkursion) *Inhalte*: Acker- und pflanzenbauliche Grundlagen des ökologischen Pflanzenbaus, Humusreproduktion, Nährstoffmanagement, Fruchtfolge, Saatgutfragen, Anbau spezieller Feldfrüchte im ökologischen Landbau, symbiotische Stickstofffixierung, N-Bilanzen, ökologischer Pflanzenschutz, ökologische Pflanzenzüchtung, ökologische Grünlandnutzung, Umstellung auf den ökologischen Landbau. Im Rahmen des Moduls werden eine Ganztags- und zwei Halbtagsexkursionen durchgeführt. Diese Exkursionen sind prüfungsrelevant.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Die Studierenden sollen Fragen zu den Teilgebieten Ackerbau, Pflanzenbau, Pflanzenschutz und Pflanzenzüchtung im Rahmen des ökologischen Landbaus kompetent beantworten.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Stefan Siebert
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Agr.0366: Futtermittel** *English title: Feed Components*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden vertiefen und erweitern ihre Kenntnisse auf dem Gebiet der Futtermittel durch Vermittlung komplexer, fachbezogener Inhalte unter Berücksichtigung aktueller Forschungsergebnisse und Praxiserfahrungen. Sie werden durch selbständiges Üben und gemeinsame Ergebnisdiskussionen befähigt, Futtermittel eindeutig zu identifizieren, zu bewerten und fundierte Schlussfolgerungen für ihren Fütterungseinsatz abzuleiten. Durch Erweiterung ihrer Fähigkeiten zur bedarfsangepassten Rationsoptimierung und Fehlerdiagnose anhand von Fallbeispielen werden sie in die Lage versetzt, ihre Urteilsfähigkeit weiter zu entwickeln sowie Problemlösungen zu finden, die es in ihrem zukünftigen Berufsfeld umzusetzen gilt. Eigenständige Referate fördern die aktive Wissensaneignung und Kommunikationsfähigkeit auf wissenschaftlichem Niveau.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Futtermittel (Vorlesung, Übung) *Inhalte*: Futteraufkommen, Futtermittelmarkt, Futtermittelsicherheit. Aktuelle Regelungen im Futtermittelrecht (Zweckbestimmungen, Registrierungs-, Zulassungs-, Melde- und Kennzeichnungspflichten, Grenzwertfestlegungen für Futterinhaltsstoffe, Einsatzvorschriften, Verbote), Futtermittelklassifizierung und Grundsätze der Futterqualitätsbeurteilung. Grobfuttermittel: Spektrum, Futterwert und Einflussfaktoren, Konservierung und Konservierungserfolg, Qualitätssicherung und Qualitätsbewertung, Einsatzmöglichkeiten und -grenzen, Konzentratfuttermittel (einschließlich Nebenprodukte der Lebensmittelherstellung sowie Nebenprodukte der Bioenergieerzeugung): Spektrum, Futterwert und Einflussfaktoren, Qualitätssicherung und Qualitätsbewertung, Mischfuttermittel: Erzeugung, Spektrum, Qualitätssicherung und Einsatzrichtlinien, Futterzusatzstoffe: Zulassungsbestimmungen, Wirkungsmechanismen, Einsatzempfehlungen, Futteroptimierung: Rationsgestaltung und Rationsbeurteilung, Futtermittelbehandlung: Behandlungsverfahren zur Verbesserung des Futterwertes bzw. zur Reduzierung antinutritiver Effekte	4 SWS

Von den folgenden Prüfungen ist genau eine erfolgreich zu absolvieren:	
Prüfung: Klausur (90 Minuten)	6 C
Prüfung: Mündlich (ca. 30 Minuten)	6 C

Zugangsvoraussetzungen: Modul B.Agr.0008 muss bestanden sein.	**Empfohlene Vorkenntnisse:** keine

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jürgen Hummel
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Agr.0367: Botanisch-mikroskopische Übungen für Studierende der Agrarwissenschaften** *English title: Botanical Microscopy Course for Students in Agricultural Sciences*	6 C 4 SWS
Lernziele/Kompetenzen: Es werden Kenntnisse zum Aufbau der Pflanze, u.a. zur Differenzierung von Geweben aufgrund ihrer Funktionen vermittelt. Die Studierenden lernen den verantwortungsvollen Umgang mit dem Lichtmikroskop, Durchlichtverfahren und das Herstellen botanisch – mikroskopischer Präparate.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
Lehrveranstaltung: Botanisch-mikroskopische Übungen für Studierende der Agrarwissenschaften (Exkursion, Übung) *Inhalte*: Botanik landwirtschaftlicher Kulturpflanzen: Aufbau der gesamten Pflanze von Spross und Wurzel, einschließlich Blüte und Frucht/Samen (Karyopse, Hülse, Schote), Keimung an ausgewählten Beispielen. Mikroskopische Untersuchungen von Blatt-, Spross- und Wurzelquerschnitt; Aufbau pflanzlicher Zellen.	4 SWS
Prüfung: 9 Kurztestate zu je 15 Minuten, jeweils am Anfang eines Kurstages, ab dem zweiten Kurstag **Prüfungsvorleistungen:** Zeichnungen der Präparate, die während des Kurses angefertigt werden **Prüfungsanforderungen:** Komplexe und spezifische Kenntnisse folgender fachbezogener Inhalte: Aufbau der Pflanze, Differenzierung von Geweben aufgrund ihrer Funktionen, Umgang mit dem Lichtmikroskop, Durchlichtverfahren und das Herstellen botanisch – mikroskopischer Präparate	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Anke Sirrenberg
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 105	

Georg-August-Universität Göttingen **Modul B.Agr.0369: Regionalökonomie und -politik** *English title: Regional Economics and Policy*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erwerben in diesem Modul grundlegende Kenntnisse in der Regionalökonomie und –politik, die als Grundlage für die Analyse von Ländlichen Räumen dienen. Auf der Basis der zunächst deskriptiven Darstellung von ländlichen Räumen und Theorien erfahren die Studierenden, welche Faktoren ausschlaggebend für regionale ökonomische, ökologische und soziale Disparitäten sind. Darauf aufbauend lernen Sie anhand von Fallbeispielen, welche Förderinstrumente es für ländliche Regionen gibt und wie diese wirken. Mit diesen Kenntnissen erwerben die Studierenden grundlegende Kenntnisse für den Aufbau von neuen Unternehmen im ländlichen Raum in Bezug auf Standortwahl, Umfeldanalyse und Förderinstrumente.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Regionalökonomie und -politik (Vorlesung) *Inhalte*: Dieses Modul befasst sich mit Theorien (Cristaller, von Thünen, Parr, Krugman etc.) und Anwendungsgebieten der ländlichen Regionalökonomie (EU wie Bundespolitik). Wichtige Aspekte sind die Erklärung von wirtschaftlichen und sozialen Disparitäten, regionale Wachstumszyklen und die Erklärung von regionalen Agglomerationen. Teilaspekte des Moduls befassen sich mit den Themenbereichen: Ländliche Gesundheitsvorsorge, Infrastrukturaufbau, soziale Strukturen, Subsidiarität in der Staatsführung (Regional Governance) und einer Vielzahl anderer Aspekte des täglichen Lebens im Ländlichen Raum. In verschiedenen Fallstudien werden praktische Modelle der ländlichen Entwicklung aufgegriffen und die verfügbaren Finanzierungsquellen auf europäischer wie der deutschen Bundesebene, der Bundeslandebene und den Kreisen und Gemeinden dargestellt, analysiert und bewertet. Die Vorlesung befasst sich begleitend mit den Instrumenten zur Wirkungsanalyse (Input-Output-Analyse, System dynamische Modellierung u.ä.)	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnis der Theorien zur ländlichen Entwicklung, der Bestimmungsgründe, die zu Disparitäten führen, einzelner wichtiger Politikbereiche im ländlichen Raum und der entsprechenden Förderinstrumente. Basiskenntnisse in der Analyse von Regionen und Anwendbarkeit des Wissens auf Fallbeispiele.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Holger Bergmann
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 180	

Bemerkungen: Bei weniger als 20 Teilnehmern ist eine Präsentation (ca. 20 Minuten) als Prüfungsleistung angedacht.

Georg-August-Universität Göttingen **Modul B.Agr.0374: Ökologische Tierwirtschaft** *English title: Ecological Livestock Management*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen die speziellen Besonderheiten der Tierwirtschaft im ökologischen Landbau kennen. Mit den erworbenen Kenntnissen können sie Unterschiede zu anderen Tierhaltungssystemen analysieren. Auf der Basis der vermittelten Grundlagen können sie Empfehlungen zur Tierhaltung bei Betriebs-Umstellung auf den ökologischen Landbau geben.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Ökologische Tierwirtschaft (Vorlesung, Exkursion) *Inhalte*: Grundlagen der ökologischen Tierwirtschaft im Hinblick auf Haltungsanforderungen, ökologische Tierzucht, ökologische Tiergesundheit, ökologische Fütterung, Produktqualität, Nährstoffmanagement, Umstellung auf den ökologischen Landbau.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Kenntnisse der Tierwirtschaft im ökologischen Landbau und Fähigkeit zur Erstellung von Empfehlungen zur Tierhaltung. Weiterhin Wissen über Nährstoffmanagement, die Möglichkeiten der Umstellung auf den ökologischen Landbau, die Haltungsanforderungen der ökologischen Tierwirtschaft und über ökologische Tierzucht, Tiergesundheit und Fütterung.“	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. agr. Sabrina Elsholz
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Agr.0375: Bioinformatik** *English title: Bioinformatics*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben grundlegende Kenntnisse über elektronische Datenverarbeitungssysteme, Datenbanken und Sequenzanalysen. Sie können mit vorhandenen elektronischen Datenerfassungs- und Managementsystemen Daten erfassen. Durch die Demonstration von Datenanalysen anhand realer Datensätze erlernen sie praxisrelevante Kenntnisse bezüglich Analyseverfahren sowie Bewertung und Interpretation der Ergebnisse. Sie werden in die Lage versetzt sich eigenständig weiterführend mit Fragen der R-Programmierung und Nutzung von Softwarepaketen zum Erfassen und Analysieren von Daten zu befassen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Bioinformatik (Vorlesung, Übung) *Inhalte*: Im Rahmen dieser Veranstaltung werden grundlegende Verfahren zur elektronischen Datenerfassung und Grundlagen der Internet-basierten Bioinformatik behandelt (Datenbanksysteme). Es werden Methoden zur Analyse und Visualisierung der erhobenen Daten vorgestellt. Ein wichtiger Aspekt ist darüber hinaus die Einführung in R-Programmierung. Alle behandelten Konzepte werden praktisch im Rahmen von (Computer-) Übungen vertieft.	4 SWS
Prüfung: Mündlich (ca. 20 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse von Datenbanken, Programmierung sowie Analyse und Visualisierung von Daten.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Felix Heinrich
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Agr.0376: Angewandte Verhaltensökonomie** *English title: Applied Behavioural Economics*	6 C 4 SWS

Lernziele/Kompetenzen: Ein vertiefter Einblick in verhaltensökonomische Sachverhalte wird vermittelt, um bewusstes und rationales Entscheiden zu fördern. Die Studierenden lernen Einflüsse auf die Entscheidungsfindung und deren Einschätzung kennen. Durch die Vermittlung dieser Inhalte können „Verhaltensfehler“ im privaten und beruflichen Kontext erkannt und vermieden werden.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Angewandte Verhaltensökonomie (Vorlesung, Übung) *Inhalte*: In diesem Modul liegt das Augenmerk auf der Entscheidungsfindung von Personen. Es wird dargestellt was rationale Entscheidungen kennzeichnet und in welchen Zusammenhängen Menschen von rationalen Entscheidungen abweichen. Diese Teildisziplin der Ökonomie wird als „Verhaltensökonomie“ bezeichnet. Das Modul beginnt mit einer Einführung in die methodische Herangehensweise an verhaltensökonomische Probleme. Anschließend werden ausgewählte Teilgebiete der Verhaltensökonomie näher betrachtet, um daraus Rückschlüsse auf die rationale und irrationale Entscheidungsfindung abzuleiten. Dabei werden die Themen: Heuristiken, Framing, Priming, Nudging, intertemporale Entscheidungen und Spieltheorie behandelt und an Beispielen erklärt.	4 SWS
Prüfung: Klausur (60 Minuten, Gewichtung: 66%) und Präsentation (ca. 10 Minuten, Gewichtung: 34%) **Prüfungsvorleistungen:** Regelmäßige Teilnahme am Unternehmensplanspiel (ca. 16 Stunden) **Prüfungsanforderungen:** Die Prüfungsleistung besteht aus der termingerechten Teilnahme am Unternehmensplanspiel, einer Präsentation sowie einer Klausur. In der Präsentation wird ein Entscheidungsproblem behandelt, durch welches Kenntnisse der Verhaltensökonomie und der methodischen Herangehensweise an verhaltensökonomische Probleme durch die Studierenden erarbeitet werden.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Oliver Mußhoff
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**

Georg-August-Universität Göttingen **Modul B.Agr.0377: Tiergesundheit** *English title: Animal Health*	6 C 4 SWS

Lernziele/Kompetenzen: Beurteilung der Tiergesundheit landwirtschaftlicher Nutztiere. Erkennen und verstehen von Krankheiten	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Tiergesundheit (Vorlesung, Übung) *Inhalte*: **1. Allgemeine Krankheitslehre** Das Modul setzt sich aus einer Vorlesung mit Übung und einem Blockunterricht zusammen. Den Studierenden sollen die Krankheitsmechanismen, die Untersuchungsmethoden und die speziellen Krankheiten der landwirtschaftlichen Nutztiere vermittelt werden. **2. Propädeutik mit Übung** Dazu werden Lerninhalte aus den Bereichen allgemeine Krankheitslehre (Pathologie, Pathophysiologie), Propädeutik und spezielle Krankheitslehre vermittelt. **3. Spezielle Krankheitslehre mit Übung** Unterstützend zur Vorlesung findet eine Üebung statt (Versuchsgut Relliehausen), bei der die Studierenden das Erkennen von Krankheiten üben sollen.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Krankheitsmechanismen, Krankheitssymptome, wesentliche Krankheiten erkennen und bewerten können.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** apl. Prof. Dr. Stephan Neumann
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Agr.0378: Experimentelle Pflanzenzüchtung - Klassisch, modern, ökologisch** *English title: Experimental Plant Breeding - Classical, Modern and Organic*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen ihr Grundwissen in Biologie und Genetik auf die Pflanzenzüchtung zu übertragen und anzuwenden. Sie sind in der Lage, technische Erfordernisse und praktische Restriktionen bei der Ausarbeitung von Problemlösungen zu berücksichtigen. Sie verfügen über Erfahrungen im Umgang mit Fachleuten aus Theorie und Praxis und können mit diesen über aktuelle Probleme und Lösungsmöglichkeiten auf wissenschaftlichem Niveau diskutieren. Sie lernen Gemeinsamkeiten und Unterschiede konventioneller und ökologischer Pflanzenzüchtung zu verstehen.	**Arbeitsaufwand:** Präsenzzeit: 62 Stunden Selbststudium: 118 Stunden
Lehrveranstaltung: Experimentelle Pflanzenzüchtung (Praktikum, Vorlesung, Exkursion) *Inhalte*: Die Studierenden erlernen grundlegende Kenntnisse der genetischen Prinzipien der Pflanzenzüchtung und bekommen einen detaillierten Einblick in pflanzenzüchterische Versuche im Feld und im Labor, einschließlich Datenerfassung und Dateninterpretation. Zentrale Inhalte sind die praktische Erprobung wichtiger klassischer und moderner Züchtungstechniken (ANOVA, Bonitur, Kreuzungstechniken, Mutationsauslösung, GC, HPLC, NIRS, Durchflusszytometrie, Zell- und Gewebekultur, molekulare Marker). Aktuelle Anwendungen und Probleme der Verfügbarkeit genetischer Ressourcen werden im Rahmen von Exkursionen zu praktischen Pflanzenzüchtungsunternehmen sowie zur Genbank diskutiert. Aspekte der ökologischen Pflanzenzüchtung werden an mehreren Fruchtarten erarbeitet. Methoden der Linien- und Populationszüchtung werden an Tomaten bzw. Mais erläutert. Resistenzzüchtung wird bei Tomaten demonstriert. Bei Körnerleguminosen werden Beikraut-Toleranz und Standortanpassung im Nachbau (Hofsorten) untersucht.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse der genetischen Prinzipien der Pflanzenzüchtung und wichtiger Züchtungstechniken.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Christian Möllers
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Modul B.Agr.0381: Forschungsorientiertes Lehren und Lernen (FoLL) I** *English title: Research based teaching and studying I*	3 C (Anteil SK: 3 C) 2 SWS

Lernziele/Kompetenzen: Den Studenten werden analytische Kompetenzen mit modernen Methoden vermittelt. Sie erlernen konzeptuelles Arbeiten unter Zuhilfenahme wissenschaftlicher Literatur. Weiterhin werden sie befähigt, im Team zu arbeiten und sich gegenseitig über Informationen, Probleme und Lösungen auszutauschen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Forschungsorientiertes Lehren und Lernen (FoLL) I (Übung, Seminar) *Inhalte*: Ziel der Veranstaltung ist die Entwicklung einer Projektidee, sowie die konzeptionelle Ausarbeitung der Idee als Projektantrag (Hausarbeit).	2 SWS
Prüfung: Hausarbeit (max. 4 Seiten) **Prüfungsanforderungen:** Fähigkeit zur konzeptuellen Bearbeitung, eigenständig und im Team, verschiedener Themen an Hand von wissenschaftlicher Literatur. Einreichung der Projektidee bei der Universität Göttingen.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 8	

Georg-August-Universität Göttingen **Modul B.Agr.0382: Forschungsorientiertes Lehren und Lernen (FoLL) II** *English title: Research based teaching and studying II*	3 C (Anteil SK: 3 C) 2 SWS

Lernziele/Kompetenzen: Nach erfolgreicher Evaluierung eines Projektantrages aus dem Modul B.Agr.0381.Forschungsorientiertes Lehren und Lernen (FoLL) I durch die Universität, nehmen die Studierenden an zentralen Workshops der Hochschuldidaktik teil, die auch dem Erlernen von Softskills dienen und stellen die Ergebnisse des Projektes hochschuloffen auf einem Poster und in einem Vortrag dar.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Forschungsorientiertes Lehren und Lernen (FoLL) II (Seminar) *Inhalte*: Themen und Inhalte der Workshops der Hochschuldidaktik.	2 SWS
Prüfung: Präsentation (ca. 20 Minuten) mit schriftlicher Ausarbeitung (max. 1 Seite) **Prüfungsanforderungen:** Fähigkeit der visuellen und verbalen Darstellung eigener Projektideen und deren Ergebnisse.	3 C

Zugangsvoraussetzungen: Die Teilnahme ist nur möglich, wenn das Modul B.Agr.0381.Forschungsorientiertes Lehren und Lernen (FoLL) I erfolgreich bestanden wurde und der Projektantrag aus dem Modul B.Agr.0381 von der Universität erfolgreich evaluiert wurde.	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiendekan
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 8	

Georg-August-Universität Göttingen **Modul B.Agr.0383: Abfassen von wissenschaftlichen Arbeiten und Publikationen in WiSoLa und Agribusiness** *English title: Drafting of Scientific Work and Publications in WiSoLa and Agribusiness*	6 C (Anteil SK: 6 C) 2 SWS
Lernziele/Kompetenzen: Studierende erlernen grundsätzliche Techniken des wissenschaftlichen Arbeitens. Diese Techniken werden in Vorlesungen vermittelt und in Übungen und Seminaren von den Studierenden angewendet. Die Studierenden beherrschen Methoden der Literaturrecherche, der Darstellung von Analyseergebnissen in Grafiken und Tabellen sowie die Anwendung einfacher beschreibender Statistik für Ergebnispräsentationen. Sie erarbeiten eigenständig ein wissenschaftliches Thema im Rahmen einer Seminararbeit mit Feedback.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden
Lehrveranstaltung: Wissenschaftliches Arbeiten (Vorlesung, Seminar) *Inhalte*: Es werden grundsätzliche Techniken wissenschaftlichen Arbeitens, die von Bachelorabsolventen der Studienrichtung Agribusiness und WiSoLa verlangt werden, vermittelt. Dazu zählen: Wissenschaftliches Schreiben und Strukturen, Literaturbeschaffung, Literaturauswertung, Darstellung von Ergebnissen in Tabellen und Grafiken, Gestaltung von Vorträgen und Handouts, Präsentation, Anfertigung einer Bachelor- wie Masterarbeit. (Vorlesungs- plus Übungsteil des Moduls). Die Lehrform setzt sich zu etwa gleichen Teilen aus Vorlesungen und Seminarbesuch zusammen.	2 SWS
Prüfung: 4 Protokolle (je mind. 1 Seite) **Prüfungsanforderungen:** Kenntnisse der grundsätzlichen Techniken des wissenschaftlichen Arbeitens.	3 C
Lehrveranstaltung: Wissenschaftliches Schreiben (Seminar) *Inhalte*: Im zweiten Teil des Moduls müssen Vorträge des „Agrarökonomischen Seminars“ besucht werden und zu einem der mindestens 12 besuchten Vorträge eine wissenschaftliche Ausarbeitung von mindestens 15 Seiten Umfang.	2 SWS
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsanforderungen:** Kenntnisse in der wissenschaftlichen Ausarbeitung von Hausarbeiten.	3 C
Prüfungsanforderungen: Grundsätzliche Techniken der Beherrschung des Anfertigens von Seminarpapiers und der vier (4) Protokolle sowie der Bewertung der Beteiligung an der Lehrveranstaltung.	

Zugangsvoraussetzungen: Gewählte Studienrichtung Agribusiness oder WiSoLa, mind. 4. Studiensemester	**Empfohlene Vorkenntnisse:** keine
Sprache:	**Modulverantwortliche[r]:**

Deutsch, Englisch	Dr. Holger Bergmann
Angebotshäufigkeit: jedes Semester	**Dauer:** 2 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 100	

Bemerkungen: Das Teilmodul 1 läuft über ein Semester. Das Teilmodul 2 läuft über zwei Semester.

Georg-August-Universität Göttingen **Modul B.Agr.0384: Grundlagen der Lebensmittelsensorik und des Sensorikmarketings** *English title: Basics of food sensory and sensory marketing*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden kennen die grundlegenden Prinzipien und die Anwendungsfelder lebensmittelsensorischer Untersuchungs- und Forschungsverfahren und können daraus gewonnene Erkenntnisse im Lebensmittelmarketing anwenden. Sie kennen damit die Grundlagen, um in der Produktentwicklung und im Produktmarketing von Lebensmittelunternehmen Aufgaben in Forschung und Entwicklung sowie im Produktmanagement zu übernehmen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Grundlagen der Lebensmittelsensorik und des Sensorikmarketings (Vorlesung, Übung) *Inhalte*: Der Stellenwert der Lebensmittelsensorik für die Agrar- und Ernährungswirtschaft steigt stetig. Im Modul werden verschiedene Prüfverfahren der Lebensmittelsensorik (u. a. deskriptive Prüfung, diskriminierende Prüfung, hedonische Tests), instrumentelle und analytische Verfahren der Sensorik (Textur, Farbe, Geschmacks- und Aromastoffe), marketingbezogene Verfahren der Sensorik (u. a. Eye Tracking, fNIRS), Marketing mit Sensorik (insb. Sensorik-Claims, Labelling, Marktsegmentierung und Produktpositionierung) vorgestellt. In Übungen und Seminaren werden u. a. im Sensoriklabor der Fakultät die verschiedenen Testverfahren an pflanzlichen und tierischen Produkten von den Studierenden praktisch erfahren sowie deren Konzeption diskutiert.	4 SWS
Prüfung: mündliche Prüfung (30 Minuten) 75%, Vortrag zu einem selbstgewählten Paper 25% **Prüfungsvorleistungen:** Regelmäßige Teilnahme an den Übungen (max 2 Fehltermine erlaubt) **Prüfungsanforderungen:** Die Studierenden zeigen in der Prüfung, dass sie die Verfahren der sensorischen und analytischen Prüfung in ihren Grundlagen beherrschen und dass sie die daraus gewonnenen Erkenntnisse im Produktmanagement und –marketing umsetzen können. Die Studierenden präsentieren in einem Kurzvortrag Hintergrund, Methodik und Studienergebnisse aus einem selbstgewählten Paper und diskutieren dabei insbesondere den Einsatz der angewendeten Verfahren.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Susanne Neugart
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Agr.0385: Praxisrelevante Fragestellungen der Betriebsführung** *English title: Applied Farm Management Questions*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen ihre Erfahrungen und Problemfelder des Betriebspraktikums mithilfe des erworbenen Wissens des bisherigen Studiums auszuwerten. Sie können die betrieblichen Praxisprobleme auf einer fortgeschrittenen Stufe des wissenschaftlichen analytischen Denkens übertragen und neben betriebswirtschaftlichen, juristischen und ökologischen auch soziale Zusammenhänge integrieren. Sie sind in der Lage ihre Problemlösungen in einem Vortrag mitzuteilen und können in der Diskussion ihre gesamtbetrieblichen Lösungen vertreten.	**Arbeitsaufwand:** Präsenzzeit: 48 Stunden Selbststudium: 132 Stunden
Lehrveranstaltung: Praxisrelevante Fragestellungen der Betriebsführung *Inhalte*: Die Studierenden werden im Rahmen der Veranstaltung zunächst in die Grundlagen der Technik wissenschaftlicher Recherchen sowie Vortrags- und Darstellungsmethoden eingewiesen. Die Studierenden stellen ihre Praxisbetriebe anhand von ausgewählten Arbeits- und Problembereichen vor und verbinden ihre Praxiserfahrungen mit den Kenntnissen aus den ersten 3 Semestern des wissenschaftlichen Studiums der Agrarwissenschaften.	4 SWS
Prüfung: Hausarbeit (max. 15 Seiten, Gewichtung: 50%) und mündlicher Vortrag (ca. 30 Minuten, Gewichtung: 50%). **Prüfungsanforderungen:** Erwerb fortgeschrittener Kenntnisse der gesamtbetrieblichen Entscheidungssituation. In der Präsentation wird die Darstellung der landwirtschaftlichen Praxis (z.B. Betrieb) und des ausgewählten Problem- und Arbeitsbereiches, die vorgestellten Lösungen und die Fähigkeit zu wissenschaftlich objektiver Abwägung in einer Diskussion bewertet. Der schriftliche Beitrag soll aufbauend auf den praktischen Erfahrungen und den theoretischen Kenntnissen der Teilnehmenden die Fähigkeit zur gesamtbetrieblichen Analyse und Entscheidungsfindung vermitteln. Im Kern steht dabei ein Problem, dessen Lösungen mit Hilfe verschiedener Indikatoren bewertet wird.	6 C

Zugangsvoraussetzungen: Abgeschlossenes Basispraktikum und nachgewiesener Besuch von mindestens 8 Vorträgen einer der studentischen Arbeitsgemeinschaften (Ackerbau, Milch, Schwein, Pferd, Internationales)	**Empfohlene Vorkenntnisse:** Erfolgreicher Besuch eines Moduls zum wissenschaftlichen Arbeiten, Schreiben und Präsentieren der Studienrichtungen
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Holger Bergmann
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 60	

Georg-August-Universität Göttingen **Modul B.Agr.0389: Seminar Umwelt- und Ressourcenökonomie** *English title: Seminar on Environmental and Resource Economics*	6 C 4 SWS
Lernziele/Kompetenzen: In diesem Seminar werden wechselnde Themenbereiche der Umwelt- und Ressourcenökonomie vertieft. Der Schwerpunkt liegt dabei auf international relevanten Problemstellungen. Die Studierenden fertigen Hausarbeiten zu ausgewählten Fragestellungen an, die anschließend im Seminar vorgetragen und diskutiert werden. Dadurch werden die Studierenden mit aktuellen Problemen der Ressourcennutzung vertraut gemacht und in die Lage versetzt, Lösungen für eine verbesserte Ressourcennutzung zu erarbeiten. Die Studierenden erlangen durch diese Lehrveranstaltung außerdem Kompetenzen des wissenschaftlichen Arbeitens (Literaturrecherche, richtiges Zitieren, Verfassen von Seminararbeiten, Vortragen von wissenschaftlichen Inhalten).	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Seminar Umwelt- und Ressourcenökonomie (Seminar) *Inhalte*: Das Seminar behandelt wechselnde Themenschwerpunkte, die jeweils in der Einführungsveranstaltung bekanntgegeben werden. Mögliche Themenblöcke umfassen z.B. "Internationale Probleme der Ressourcennutzung", "Ressourcennutzung und nachhaltige Entwicklung" oder "Nachhaltigkeitsstandards in der Landwirtschaft".	4 SWS
Prüfung: Referat (ca. 30 Minuten, Gewichtung: 40%) und Hausarbeit (max. 10 Seiten, Gewichtung: 60%) **Prüfungsvorleistungen:** Anwesenheitspflicht im Seminar **Prüfungsanforderungen:** Weiterführende Kenntnisse international relevanter Probleme der Umwelt-und Resourcenökonomie. Die konkreten Themen werden jedes Jahr aktualisiert. Das Verfassen einer Seminararbeit (Literatursuche und -abgrenzung; Gliederung, korrekte Zitierweise, Erfüllung sonstiger formale Kriterien) und die Vorbereitung und Durchführung einer mündlichen Präsentation.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Doris Läpple
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Bemerkungen:

Das Modul B.Agr.0389 kann nur belegt werden, wenn keine Prüfung im Modul B.Agr.0398 erfolgreich absolviert wurde.

Die Platzvergabe erfolgt am ersten Veranstaltungstermin.

Georg-August-Universität Göttingen **Modul B.Agr.0390: Einführung in die Grundlagen der Soziologie und Demographie – insbesondere ländlicher Räume** *English title: Principles of Sociology and Demography*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studentinnen und Studenten werden in die Grundlagen der Soziologie und Demographie eingeführt, dazu gehören Grundkenntnisse in der demographischen und sozialstrukturellen Theorie, Familiensoziologie - insbesondere der Soziologie ländlicher Räume wie beispielsweise Stadt-Land-Wanderung, Gleichwertigkeit der Lebensverhältnisse oder neue Ländlichkeit. Diskutiert werden aktuelle sozialökonomische und lebensweltliche Entwicklungen. Dies soll eine differenzierte Betrachtung des sozialen Wandels ermöglichen, die zu eigenen Analysen und Bewertungen befähigt.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Einführung in die Grundlagen der Soziologie und Demographie – insbesondere ländlicher Räume (Vorlesung, Übung) *Inhalte*: Im Zentrum der Veranstaltung steht die Frage nach den Ursachen, dem Verlauf und den Konsequenzen des gesellschaftlichen Wandels. Besonders der Demographische Wandel wird unsere Gesellschaft nachhaltig verändern: Wir werden älter und bunter. Der alte Stadt - Land - Unterschied greift nicht mehr, denn wir sehen sowohl wachsende als auch schrumpfende Regionen dicht nebeneinander. Dennoch stellt die Alterung der Gesellschaft uns vor große Herausforderungen (Stichworte: Sozialsysteme, Daseinsvorsorge). Gleichzeitig verändern sich die einzelnen Lebensphasen und das Geschlechterverhältnis. Die Lebensläufe von Männern und Frauen gleichen sich an und einzelne Lebensphasen differenzieren sich zunehmend (das "zweite", "dritte", "vierte" Lebensalter). Zugleich verändert bereits heute die Digitalisierung unsere Arbeits-, Lebens- und Kommunikationswelt. Was heißt das für ländliche Räume? Gibt es überhaupt noch eine ländliche Gesellschaft? Wie werden wir in Zukunft leben?	4 SWS
Prüfung: Präsentation (ca. 30 Minuten) **Prüfungsanforderungen:** Grundlagen Demographie, Sozialstruktur, Soziologie sozialer Ungleichheit, Soziologie ländlicher Räume, Familiensoziologie. Die Präsentation besteht aus einem Präsentationsteil (ca. 20 Minuten) und einem Diskussionsteil (ca. 10 Minuten).	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Claudia Neu
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**

Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul B.Agr.0391: Ernährungssoziologie und Global Food Trends** *English title: Nutrition Sociology and Global Food Trends*	6 C

Lernziele/Kompetenzen: Die Studentinnen und Studenten werden in die Grundlagen der Ernährungssoziologie und die Thematik der Global Food Trends eingeführt. Diskutiert werden die aktuelle Ernährungsversorgungssituation und Ansätze zur Verbesserung der Ernährungssicherheit, die zu eigenen Analysen und Bewertungen befähigt.	**Arbeitsaufwand:** Präsenzzeit: 40 Stunden Selbststudium: 140 Stunden

Lehrveranstaltung: Ernährungssoziologie und Global Food Trends (Blockveranstaltung) *Inhalte*: Im Zentrum der Veranstaltung stehen Ursachen, Verläufe und Konsequenzen von Ernährungsunsicherheit und ihre unterschiedliche Ausprägung in verschiedenen Regionen der Welt. In diese Betrachtung werden demographische Veränderungen und Ernährungsverhaltensweisen in Krisensituationen einbezogen. Des Weiteren werden Lösungsansätze für mehr Ernährungssicherheit aufgezeigt und unter Nachhaltigkeitsaspekten bewertet.	
Prüfung: Präsentation (ca. 10 Minuten, 75%) mit schriftlicher Ausarbeitung (max. 5 Seiten, 25%) **Prüfungsanforderungen:** Grundlagen der Ernährungssoziologie, soziologische Einflüsse auf die Ernährung, Ernährungsversorgungssituation, Ansätze zur Verbesserung der Ernährungssicherheit, Herausforderungen bei der Lebensmittelproduktion, Global Food Trends	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Claudia Neu
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Agr.0392: Wissenschaftliches Arbeiten und professionelles Präsentieren in den Nutztierwissenschaften** *English title: Scientific Writing and Professional Presentation in Animal Sciences*	6 C (Anteil SK: 6 C) 4 SWS
Lernziele/Kompetenzen: Das Modul dient der Vorbereitung auf die Bachelorarbeit. Die Studierenden sollen in die Lage versetzt werden, eine Arbeit eigenständig mit Berücksichtigung gute wissenschaftliche Praxis zu erstellen und wissenschaftliche Inhalte in geeigneter Form präsentieren zu können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Wissenschaftliches Arbeiten und professionelles Präsentieren in den Nutztierwissenschaften (Seminar) *Inhalte*: • Literaturbeschaffung, • Literaturauswertung, • Darstellung von Ergebnissen in Tabellen und Grafiken an Hand einfache statistische Auswertungen, • Gestaltung von Vorträgen und Handouts, • Präsentationstechniken, • Abfassung einer schriftlichen wissenschaftlichen Arbeit • Gute wissenschaftliche Praxis & Ethik in der Wissenschaft Im Seminarteil des Moduls können sich die Studierenden ein Thema aus dem Bereich der Nutztierwissenschaften wählen. Zu diesem Thema halten die Studierenden einen Vortrag in Form einer Konferenzbeitrag (Szenario-Prüfung mit Abstract und mündliche Präsentation). Das Thema des Vortrages wird auch Thema der Hausarbeit sein, bei der die Studierenden Feedback zur/Diskussion deren Thema von der Konferenz einarbeiten/berücksichtigen können. Die Lehrform setzt sich aus wöchentlichen Vorlesungen (Form variiert), Seminarvorträgen und der Hausarbeit zusammen. Daneben werden einige Schreibberatungstermine angeboten, die Studierende einzeln oder in Kleingruppen wahrnehmen können.	4 SWS
Prüfung: Präsentation (ca. 15 Minuten) mit schriftlicher Ausarbeitung (max. 1 Seite) (Gewichtung: 50%) und Hausarbeit (max. 15 Seiten) (Gewichtung 50%) **Prüfungsvorleistungen:** Regelmäßige Teilnahme am Seminar; Nachgewiesene Teilnahme an 5 wissenschaftlichen Vorträgen **Prüfungsanforderungen:** Die Präsentation erfolgt in einem Konferenz-Szenario. Kenntnisse der grundsätzlichen Techniken wissenschaftlichen Arbeitens insbesondere gute wissenschaftliche Praxis, Literaturauswertung und Beschaffung, Ergebnisdarstellung, Gestaltungskompetenzen, Präsentationstechniken sowie Abfassung von schriftlichen Texten.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache:	**Modulverantwortliche[r]:**

Deutsch	Prof. Dr. Daniel Mörlein
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** ab 4
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Agr.0394: Zucht, Haltung und Ernährung spezieller Nutztiere** *English title: Breeding, Husbandry and Nutrition of Special Livestock*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erlernen die theoretischen Hintergründe der Zucht und Haltung spezieller landwirtschaftlicher Nutztiere sowie deren Nutzung. Sie können mit diesen Informationen fachbezogene Probleme auf Praxisbetrieben erkennen und selbstständig lösen. Die Studierenden sind in der Lage die tiergerechte Gestaltung von Haltungssystemen spezieller landwirtschaftlicher Nutztiere umzusetzen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Zucht, Haltung und Ernährung spezieller Nutztiere (Vorlesung) *Inhalte*: Haltung und Zucht folgender spezieller Nutztiere: • Kaninchen • Geflügel: Strauße, Enten, Gänse, Perlhühner, Wachteln, Fasanen • Kameliden (Lamas und Alpakas) • Büffel • Gehegewild • Bienen und Hummeln Darüber hinaus werden Grundlagen zur Fütterung sowie zur jeweiligen Nutzung und zu Produkten vermittelt. Es werden die rechtlichen Rahmenbedingungen der Haltung erörtert.	
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Spezielle Kenntnisse zu Zucht und Haltung der oben genannten Arten. Grundkenntnisse zu Fütterung und Produkten	6 C

Zugangsvoraussetzungen: Grundlagen der Nutztierwissenschaften I/II	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jens Tetens
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 80	

Georg-August-Universität Göttingen **Modul B.Agr.0397: Pflanzenschutztechnik** *English title: Crop Protection Technology*	3 C 2 SWS
Lernziele/Kompetenzen: Die Studierenden kennen verschiedene Möglichkeiten des chemischen und des physikalischen Pflanzenschutzes. Sie sollen die sachgerechte Anwendung von Pflanzenschutzverfahren erlernen und diese bewerten können sowie die geeigneten Verfahren für verschiedene Anwendungen ermitteln. Sie können Gefährdungspotenziale fu¨r die Umwelt einschätzen und durch Auswahl verschiedener Verfahren vermindern. Das Modul ist Bestandteil des Sachkundenachweises für die Anwendung chemischer Pflanzenschutzmittel.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Pflanzenschutztechnik (Vorlesung, Übung) *Inhalte*: Übersicht u¨ber Pflanzenschutzverfahren; chemische Pflanzenschutztechnik, mechanische Pflanzenschutztechnik, technische Voraussetzungen; Gerätewahl und -auslegung; Entstehung und Vermeidung von Abdrift; Verlustmindernde Technik; Technik zur Erfu¨llung von Abstandsauflagen; Elektronikeinsatz beim Pflanzenschutz; Rechtliche Rahmenbedingungen bei der Anwendung von Pflanzenschutztechnik; Persönliche Schutzausrüstung. In den Übungen werden ausgewählte Vorlesungsinhalte vertieft.	2 SWS
Prüfung: Klausur (45 Minuten) **Prüfungsvorleistungen:** Verpflichtende Teilnahme an allen Übungen. Praktische Prüfung (unbenotet) an einem Pflanzenschutzgerät. **Prüfungsanforderungen:** Grundlegende Kenntnisse in den Bereichen • Anwendung physikalischer und chemischer Verfahren; • Geräteaufbau und –verwendung; • Bewertung von Pflanzenschutzverfahren	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Frank Beneke
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Agr.0398: Seminar Nachhaltiges Landmanagement** *English title: Sustainable Land Management*	6 C 4 SWS
Lernziele/Kompetenzen: In diesem Seminar werden wechselnde Themenbereiche des nachhaltigen Landmanagements vertieft. Der Schwerpunkt liegt dabei auf international relevanten Problemstellungen. Die Studierenden fertigen Hausarbeiten zu ausgewählten Fragestellungen an, die anschließend im Seminar vorgetragen und diskutiert werden. Dadurch werden die Studierenden mit aktuellen Problemen einer nachhaltigen Landnutzung vertraut gemacht und in die Lage versetzt, Lösungen für eine verbesserte Ressourcennutzung zu erarbeiten. Die Studierenden erlangen durch diese Lehrveranstaltung Kompetenzen des wissenschaftlichen Arbeitens (Literaturrecherche, richtiges Zitieren, Verfassen von Seminararbeiten, Vortragen von wissenschaftlichen Inhalten).	**Arbeitsaufwand:** Präsenzzeit: 64 Stunden Selbststudium: 116 Stunden
Lehrveranstaltung: Seminar Nachhaltiges Landmanagement (Seminar) *Inhalte*: Das Seminar behandelt wechselnde Themenschwerpunkte, die jeweils in der Einführungsveranstaltung bekanntgegeben werden. Mögliche Themenblöcke umfassen z.B. „Nachhaltige Ernährungssysteme", „Konflikte zwischen Landwirtschaft und Naturschutz" oder „Ökologischer Fußabdruck der Landwirtschaft".	4 SWS
Prüfung: Referat (ca. 30 Minuten, Gewichtung: 40%) und Hausarbeit (max. 10 Seiten, Gewichtung: 60%) **Prüfungsanforderungen:** Weiterführende Kenntnisse von Ansätzen des nachhaltigen Landmanagements. Verfassen einer Hausarbeit (Literatursuche und -abgrenzung; Gliederung, korrekte Zitierweise, Erfüllung sonstiger formaler Kriterien) sowie Abhalten einer mündlichen Präsentation.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Tobias Plieninger
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Bemerkungen:
Das Modul B.Agr.0398 kann nur belegt werden, wenn keine Prüfung im Modul B.Agr.0389 erfolgreich absolviert wurde.

Georg-August-Universität Göttingen **Modul B.Agr.0401: Übungen zur Herbologie** *English title: Weed Science Training*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden sind in der Lage Unkräuter im frühen Keimstadium zu identifizieren und taxonomisch zuzuordnen. Sie kennen die wirtschaftliche Bedeutung der einzelnen Unkrautarten und sind in der Lage Nutzen und Schaden in der Landwirtschaft abzuwägen. Die Bedeutung der Konkurrenz von Kultur und Unkraut wird verstanden.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Übungen zur Herbologie (Vorlesung, Übung) *Inhalte*: Grundlagen der Unkrautbestimmung anhand von Samen und Keimlingen mit Übungen. Besonderheiten von häufigen und wichtigen Arten, sowie von seltenen und invasiven Arten mit Bestimmungsübungen. Studium der Kultur-Unkraut-Interaktionen durch Anlage und Auswertung eines Konkurrenzversuchs am Beispiel Zuckerrübe.	4 SWS
Prüfung: Klausur (90 Minuten, Gewichtung 85%) und Präsentation (ca. 10 Minuten, Gewichtung 15%) **Prüfungsanforderungen:** Artbestimmung der Pflanzen anhand von Samen, Keimlingen, Habitus und Blüten. Aufzählung der wichtigsten Unkrautarten in verschiedenen Kulturen. Verständnis über die Kultur-Unkraut- Interaktion.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Jean Wagner
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Agr.0402: Agrarökologie, Agrobiodiversität und biotischer Ressourcenschutz** *English title: Agroecology, Agrobiodiversity and Biotic Resource Protection*	6 C 6 SWS

Lernziele/Kompetenzen: Verstehen und Anwenden grundsätzlicher Methoden der Analyse und Bewertung von Ökosystemen; Zusammenhänge zwischen Biodiversität und der Funktionsfähigkeit von Ökosystem kennen, Beurteilung der Folgen des Globalen Wandels für Kulturlandschaft und Agrarökosysteme, Auseinandersetzung mit aktuellen Problemen der Ökologie anthropogen genutzter Systeme, Fähigkeit zur problemlösenden Anwendung des erlernten Wissens. Teilmodul 2: Ökologie der Agrarlandschaft Die Studierenden sollen die Lebensraumtypen und Lebensgemeinschaften der Agrarlandschaft so kennenlernen, dass sie Bewertungen unter Naturschutz-Gesichtspunkten vornehmen können. Dazu gehören genaue Vorstellungen, was Biodiversität, Schädlings-Nützlings-Interaktionen, Lebensraum-Verinselung oder die Stabilität von Ökosystemen bedeuten und wie sie im Freiland zu erfassen sind.	**Arbeitsaufwand:** Präsenzzeit: 78 Stunden Selbststudium: 102 Stunden

Lehrveranstaltung: Agrarökologie und Agrobiodiversität (Vorlesung) *Inhalte*: Biodiversität in Agrarsystemen, Ökosystemfunktionen, Gratisleistungen der Natur und Globale Umweltveränderungen, Populationsökologie und Naturschutz, weltweite Muster der Primär- und Sekundärproduktion, Vergleich gemanagter und natürlicher Wasser- und Landökosysteme, Größe und Isolation von Lebensräumen, Saumbiotope und Ausbreitungsverhalten in Agrarlandschaften, Historische Biogeographie und Klimawandel.	2 SWS
Prüfung: Klausur (45 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse der Agrarökologie, der Biodiversität und der Ökosystemfunktionen in Agrarsystemen in Abhängigkeit vom Globalen Wandel, Naturschutzperspektiven in der Agrarlandschaft.	3 C

Lehrveranstaltung: Ökologie der Agrarlandschaft (Übung, Seminar) *Inhalte*: Kennenlernen der Vielfalt an Organismen verschiedener landwirtschaftlich genutzter oder beeinflusster Lebensräume (Gewässer, Acker, Grünland, Brachen, Sukzessionsflächen, Ackerrandstreifen, Magerrasen, u.v.a.), Artenreichtum ausgewählter limnischer und terrestrischer Lebensräume mit ihren charakteristischen Pflanzen- und Tierarten, praktische Untersuchungen zur Gewässergüte, zu den Folgen der Beweidung, zur Produktivität der Vegetationsdecke und zu Lebensraum-Randeffekten für den Artenreichtum, Lebensraum-Beurteilung anhand des Artenreichtums, Bestimmung und Systematik wirbelloser Tiere sowie deren Einteilung in ökologische Gruppen (z.B. Bestäuber, Räuber, Pflanzenfresser). Es wird eine Exkursion zum Thema traditionelle Landnutzung in den Naturpark Meissner durchgeführt.	4 SWS
Prüfung: Kurzreferat (ca. 5 Minuten) und Hausarbeit (max. 25 Seiten)	3 C

Prüfungsanforderungen: Erkennen und erste Bestimmung von Lebensgemeinschaften der Agrarlandschaft, Erfassung von biotischen Interaktionen, grundlegende Erfahrungen zur Anlage und Durchführung statistisch auswertbarer Untersuchungen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Westphal
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul B.Agr.0404: Forschungsorientierte Einführung in Fragestellungen der Nutztierhaltung** *English title: Research-based introduction to research in animal husbandry*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden bearbeiten in Kleingruppen an ausgewählten Beispielen die Elemente eines Versuchsaufbaus in der Nutztierhaltung einschließlich Aufbereitung und Präsentation der Ergebnisse. Die Studierenden können die spezifischen Probleme im Bereich der Nutztierhaltung analysieren, kennen zugehörige Versuchsfragestellungen und geeignete Methoden zur Bearbeitung. Darüber hinaus sind Sie in der Lage, die Analyse und Aufbereitung von Versuchsdaten im Fachgebiet durchzuführen und die Ergebnisse zu präsentieren. Sie erlernen Methoden der Erfassung und Auswertung für Fragestellungen in der Nutztierhaltung	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Forschungsorientierte Einführung in Fragestellungen der Nutztierhaltung (Vorlesung, Übung, Seminar) *Inhalte*: Anhand aktueller wissenschaftlicher Themen im Bereich der Nutztierhaltung (Aufbau und Bewertung von Haltungssystemen, Precision Livestock Farming) werden einzelne Aspekte in Kleingruppen bearbeitet. Dabei steht zunächst Literaturrecherche, Auswahl und Anwendung von Methoden zur Erfassung von Parametern (u.a. Leistung, Tierverhalten, Tiergesundheit und Tierwohl) im Vordergrund. An ausgewählten Beispielen werden diese in praktischen Übungen vertieft. Im Anschluss erfolgt die Auswertung der Parameter sowie deren Interpretation und Präsentation hinsichtlich der festgelegten Versuchsfragestellung.	4 SWS
Prüfung: Referat (10 Minuten, 25%) mit schriftlicher Ausarbeitung (max. 8 Seiten, 25%) und mündlich (ca. 15 Minuten, 50%) **Prüfungsanforderungen:** Kenntnisse zur zielgerichteten Planung, Durchführung und Auswertung von Versuchen im Bereich der Nutztierhaltung, um wissenschaftlich fundierte Aussagen zu ermöglichen.	6 C

Zugangsvoraussetzungen: Kenntnisse aus den Grundlagen der Tierzucht, -haltung und –verhalten sowie Verfahrenstechnik werden erwartet.	**Empfohlene Vorkenntnisse:** Vorkenntnisse zur Versuchsplanung und wissenschaftlichem Präsentieren sind von Vorteil.
Sprache: Deutsch	**Modulverantwortliche[r]:** apl. Prof. Dr. Lars Schrader
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Modul B.Agr.0410: Alter(n) und ländlicher Raum** *English title: The Elderly in Rural Areas*	6 C 4 SWS
Lernziele/Kompetenzen: Den Studierenden werden im Rahmen des Seminars vertiefende Kenntnisse in den demographischen Wandel und in die damit verbundenen gesellschaftlichen Auswirkungen und Herausforderungen für ländliche Räume sowie deren infrastrukturelle Ausstattung / Daseinsvorsorge vermittelt. Es wird zudem diskutiert, inwieweit die regionale Auseinandersetzung mit der zunehmenden Alterung, Entvölkerung und Peripherisierung gerade auch eine Chance darstellen kann und welche möglichen Gefahren es zu berücksichtigen gilt.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Alter(n) und ländlicher Raum (Seminar) *Inhalte*: Zentraler Inhalt des Seminars ist die Frage, inwiefern die ältere Bevölkerung als ein positiver Einflussfaktor auf die Regionalentwicklung angesehen werden kann und welche Risiken eine solche Entwicklung in sich bergen kann. Zudem werden aktuelle gesellschaftliche sowie (sozial-) politische Diskussionen (z. B. Digitalisierung, Gleichwertigkeit von Lebensverhältnissen) aufgegriffen und in die Gesamtbetrachtung einbezogen. Weitere mögliche thematische Schwerpunktsetzung kann in den Bereichen Alterssicherung von Landwirt*innen und Hofnachfolge, Ruhestandmigration *(Stichworte: Sun Cities, Retirement Communities)*, innovative Versorgungskonzepte, zur bedarfsgerechten Unterstützung der Daseinsvorsorge, Ehrenamt / bürgerschaftliches Engagement *(Stichworte: Empowerment, Hilfe zur Selbsthilfe)*, (Senioren-) Tourismus, neue Pflege- und Wohnkonzepte *(Stichworte: Care-Farms / Demenz Bauernhof, Hof WGs)* erfolgen.	4 SWS
Prüfung: Präsentation (ca. 30 Minuten, 50 %) mit schriftlicher Ausarbeitung (8 Seiten, 50 %) **Prüfungsanforderungen:** Altern in ländlichen Räumen, Demographischer Wandel und ländliche Räume, Alters- / Ruhestandsmigration und regionale Auswirkungen, Bedeutungen für Einrichtungen der ländlichen Daseinsvorsorge. Die Prüfungsleistung stellt eine Präsentation mit einem Präsentationsteil (ca. 20 Minuten), einem Diskussionsteil (ca. 10 Minuten) sowie einer schriftliche Ausarbeitung (8 Seiten) zu einer expliziten Fragestellung des Themas der Präsentation dar.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Modul B.Agr.0390
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Claudia Neu
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Agr.0411: Einführungskurs Agrartechnik - Außenwirtschaft** *English title: Agricultural Engineering – Basic Course*	3 C 2 SWS
Lernziele/Kompetenzen: Das Praktikum richtet sich an Studierende, die keine oder nur geringe Vorkenntnisse zum Einsatz landwirtschaftlicher Maschinen in der Außenwirtschaft besitzen. Die Studierenden erlernen Grundwissen zu Traktoren, Anbaugeräten und Transportfahrzeugen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Einführungskurs Agrartechnik - Außenwirtschaft (Praktikum, Laborpraktikum) *Inhalte*: Inhalte Praktikum: Im Praktikum wird Grundwissen zum Einsatz landwirtschaftlicher Maschinen in der Außenwirtschaft vermittelt. Zum Lehrinhalt gehören Aufbau und Funktionsweise von Traktoren sowie Aufbau und Betrieb (z.T. im Praxiseinsatz) ausgewählter Geräte. Inhalte Labor: Im Labor werden die Inhalte des Praktikums im Simulator vertieft und erweitert. Die Teilnehmer üben die Anwendung von Traktoren und Erntemaschinen und vertiefen ihre Kenntnisse zur Anwendung von Agrartechnik in den Produktionsketten im Pflanzenbau.	2 SWS
Prüfung: Mündlich (ca. 20 Minuten) **Prüfungsvorleistungen:** praktische Prüfungen in Kleingruppen (3 x ca. 90 min, unbenotet) **Prüfungsanforderungen:** Anmerkung zur Prüfungsvorleistung: Aufbauend auf dem Praktikumsteil bearbeiten die Teilnehmer/innen des Kurses Aufgaben im (Maschinen-)Simulator. Hier werden definierte Übungsabfolgen in Kleingruppen gelöst. Den Übungserfolg protokolliert die Software und erst bei einer erfolgreich abgeschlossenen Übung kann die nächste Einheit aufgerufen werden. Es sind daher praktische Aufgaben in Kleingruppen (3er-Gruppen) zu lösen, jede Gruppe hat mindestens 3x 90 min. nachzuweisen.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Frank Beneke
Angebotshäufigkeit: jedes Sommersemester	**Dauer:**
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** bis 2
Maximale Studierendenzahl: 21	

Georg-August-Universität Göttingen **Modul B.Agr.0413: Agrarökologie und Biodiversität** *English title: Agroecology and Biodiversity*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden sollen lernen, wie man sich ein interessantes Thema der Biodiversitätsforschung erarbeitet, wie man ökologische Experimente und Untersuchungen anlegt und welche Möglichkeiten der Datenauswertung bestehen. Sie bekommen einen breiten Überblick über die ökologische Bedeutung des Flächenmosaiks eines landwirtschaftlichen Betriebs und dessen Folgen für die Erhaltung der Biodiverstät.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Agrarökologie und Biodiversität (Blockveranstaltung) *Inhalte*: In diesem Block-Kurs werden aktuelle ökologische Fragestellungen, wie sie im Zusammenhang mit der Bewirtschaftung eines landwirtschaftlichen Betriebes auftauchen, im Hinblick auf mögliche Biodiversitäts-orientierte Experimente und Untersuchungen diskutiert. Es werden Methoden der Ökologie und Beispiele für erfolgverspechende Felduntersuchungen vorgestellt. In Kleingruppen erarbeiten sich die Studierenden ein Thema, das im folgenden unter genauer Anleitung bearbeitet wird. Beispielsweise wird anhand des Versuchsguts in Deppoldshausen untersucht, welche Rolle Waldränder und Hecken für die Besiedlung des Ackers haben, welche Lebensraumtypen für die Biodiversität besonders wichtig sind, wie sich organisch und konventionell bewirtschaftete Flächen unterscheiden, etc.	4 SWS
Prüfung: Hausarbeit (max. 20 Seiten, 70%), Referat (ca. 12 Minuten, 30%) **Prüfungsanforderungen:** Wissen über ökologische Fragestellungen, die bei der Bewirtschaftung eines landwirtschaftlichen Betriebes auftreten. Kenntnisse zu Untersuchungsmethoden der Ökologie und Beispiele für erfolgversprechende Felduntersuchungen. Überblick über Möglichkeiten der Datenauswertung. Referat: In einem 12-minutigen Referat werden die Ergebnisse der Felduntersuchungen präsentiert und kritisch diskutiert. Dies beinhaltet neben einer kurzen Einleitung die Darstellung der Untersuchungshypothesen, Feld-/Labormethoden, statistische Datenauswertung und eine Diskussion der Ergebnisse unter Einbeziehung von Sekundärliteratur, wie z.B. wissenschaftlichen Fachpublikationen (30% der Modulnote).Erarbeitung von Hausarbeit: In einer schriftlichen Hausarbeit (Umfang max. 20 Seiten) werden die Versuche im Stil einer wissenschaftlichen Veröffentlichung dargelegt. Die Hausarbeit wird hierbei gegliedert in: Zusammenfassung, Einleitung, Hypothesen, Methoden, Resultate, Diskussion und Quellen. Neben formalen Aspekten (z.B. Darstellung der Ergebnisse, Orthografie, korrekte Zitierweise) steht insbesondere die Diskussion der eigenen Ergebnisse unter Berücksichtigung der wissenschaftlichen Fachliteratur im Fokus der Prüfungsanforderungen (70% der Modulnote)	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine

Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Westphal
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Agr.0414: Agrarwirtschaftsrecht** *English title: Company and Industry Legislation in Agriculture*	6 C (Anteil SK: 6 C) 4 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen rechtliches Wissen und Grundverständnis. Dazu gehören die juristische Fachsprache, der Umgang mit Gesetzestexten (Auslegung von Rechtsnormen), die juristische Argumentation und das Erkennen von Strukturzusammenhängen im Recht. Sie erlangen die Fähigkeit, im Rahmen ihrer Tätigkeit oder ihres Berufes, auftretende juristische Fragen zu behandeln bzw. zu beantworten, juristisches Problembewusstsein zu entfalten sowie für juristische Probleme Lösungen zu entwickeln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Agrarwirtschaftsrecht (Vorlesung) *Inhalte*: • Grundbegriffe des Agrarrechts • Struktur und Systematik des Unternehmens- und Wirtschaftsrechts im Agrarbereich • Grundlagen der Agrar-Wirtschaftsordnung • Unternehmestypen und Rechtsformen im Agrarbereich • Recht der Schuldverhältnisse • Sachenrecht und Eigentumsrecht der Landwirtschaft • Recht der Vermarktung und Gewährleistungsrecht im Agrarbereich • Haftungsrecht • Erbrecht und Unternehmensnachfolge in der Landwirtschaft • Recht der Forstwirtschaft • Arbeits- und Sozialrecht im Agrarbereich • Sortenschutzrecht • Allgemeiner Rechtsschutz	4 SWS
Prüfung: Klausur (60 Minuten) **Prüfungsanforderungen:** Basiskenntnisse durch Nachweis des juristischen Grundverständnisses im Bereich Unternehmens- und Wirtschaftsrecht, juristisches Problembewusstsein und Beherrschen der juristischen Auslegungsmethoden, Beherrschen der juristischen Fachterminologie	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

40	

Georg-August-Universität Göttingen **Modul B.Agr.0415: Ernährungsphysiologie der Kulturpflanzen** *English title: Nutritional Physiology of Plants*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden können zu erwartende Wirkungen von Düngungsmaßnahmen aus physiologischer Sicht beurteilen. Sie erlangen die Fähigkeit zum Erkennen von Mangelsymptomen an Einzelpflanzen und können dies in der Bestimmung des Zustandes von Pflanzenbeständen in der Praxis anwenden. Die Studierenden können aus den Ergebnissen von Pflanzenanalysen den Ernährungszustand von Pflanzen bewerten, daraus Erkenntnisse ableiten und entsprechende Maßnahmen zur Verbesserung des Ernährungszustands oder weitergehende Untersuchungen vorschlagen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Ernährungsphysiologie der Kulturpflanzen (Vorlesung, Übung) *Inhalte*: Zellaufbau, Überblick über den pflanzlichen Stoffwechsel, Fotosynthese, Licht und Dunkelreaktionen, C3-/C4-Stoffwechsel, Assimilattransport, Phloembeladung, Source-Sink-Beziehungen, Atmung & Energiestoffwechsel, Polysaccharide, Pektine, Lignine, N-Aufnahme, N-Assimilation, N2-Fixierung, Proteinbiosynthese, Fettstoffwechsel, Mechanismen zur Abwehr von biotischem und abiotischem Stress / oxidativer Stress, Phytohormone, Seneszenz. Funktionen mineralischer Makro- und Mikronährstoffe bei der pflanzlichen Stoffbildung, weitere Funktionen im pflanzlichen Stoffwechsel wie Stressreaktionen und Reife/ Seneszenz, Ursachen und Erscheinungsbilder von Nährstoffmangelsymptomen, Wege zur Behebung von Nährstoffmangel.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Kenntnisse der Funktionen der Pflanzennährstoffe im Stoffwechsel.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse über die Bestimmung pflanzenverfügbarer Gehalte an Nährstoffen im Boden und über die Abhängigkeit ihrer Verfügbarkeit von pH-Wert und Redoxpotential des Bodens.
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Tino Kreszies
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul B.Agr.0416: Physiologische Grundlagen der Fortpflanzung bei Nutzsäugern** *English title: Basic Physiology of Reproductive Traits in Domestic Animals*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen theoretische und praktische Kenntnisse über die verschiedenen Arbeitstechniken der Reproduktion und sind mit den dafür relevanten anatomischen Unterschieden der verschiedenen Nutzsäuger vertraut. Sie sind in der Lage Wechselwirkungen verschiedener Umwelteinflüsse auf die Fortpflanzung und Leistung der Nutztiere nachzuvollziehen und können diese Kenntnisse auf die Praxis übertragen. Die relevanten Fachbegriffe werden von den Studierenden beherrscht, so dass sie in der Lage sind sich mit Fachleuten auszutauschen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Physiologische Grundlagen der Fortpflanzung bei Nutzsäugern (Vorlesung, Übung) *Inhalte*: Anatomische, physiologische und praktische Grundlagen der Reproduktion; Grundlagen der Embryologie; Regulation der Fortpflanzung bei landwirtschaftlichen Nutztiere (Neuronale und hormonelle Regulationssysteme, Umwelteinflüsse und Wechselwirkungen)	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Teilnahme an den Übungen **Prüfungsanforderungen:** In der Prüfung werden spezifische Wissens-, Könnens-, und Transferfragen aus den Bereichen Anatomie, Physiologie, Embryologie, Endokrinologie und Neurologie, unter Berücksichtigung ihrer Relevanz für das Fortpflanzungsgeschehen und die Reproduktionsleistung landwirtschaftlicher Nutzsäuger, gestellt.	6 C

Zugangsvoraussetzungen: Kenntnisse aus den im Modul "Biologie der Tiere" behandelten Themenbereichen werden erwartet.	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Michael Hölker
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 70	

Georg-August-Universität Göttingen **Modul B.Agr.0419: Marketing für Agrarprodukte und Lebensmittel** *English title: Marketing for Agricultural Products and Food*	6 C (Anteil SK: 6 C) 4 SWS

Lernziele/Kompetenzen: Die Studierenden sind mit markt- und kundenorientierten Unternehmensentscheidungen vertraut und können dieses Wissen in die Praxis transferieren. Sie erlernen die Grundlagen des klassischen Marketings ebenso kennen wie die Spezifika der Land- und Ernährungswirtschaft. In Fallstudien erproben und vertiefen die Studierenden ihre Kenntnisse anwendungsorientiert.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Marketing für Agrarprodukte und Lebensmittel (Vorlesung, Übung) *Inhalte*: Einführung in die Grundlagen des Marketings in der Agrar- und Ernährungswirtschaft. Kerninhalte sind Marktanalyse, Käuferverhaltenstheorien, Marketing-Ziele, Strategisches Marketing, Marketinginstrumentarium und Marketing-Organisation sowie -Controlling. Die Inhalte werden in Fallstudien zum Agrar- und Lebensmittelmarketing vertieft.	4 SWS
Prüfung: Klausur (60 Minuten, Gewichtung 50%) und Präsentation zu einer Fallstudie (ca. 15 Minuten, Gewichtung 50%) **Prüfungsanforderungen:** Einführende Kenntnisse der Entwicklung des Marketings, der Umfeldanalyse, von Unternehmensanalyse, Käuferanalyse, Portfoliomethodik, Marketingprognosen, Marketingziele, Marketingstrategien, Marketinginstrumente, Marketingorganisation und Marketingcontrolling.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Achim Spiller
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 200	

Georg-August-Universität Göttingen **Modul B.Agr.0420: Qualität pflanzlicher Produkte** *English title: Quality of Plant Products*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen pflanzliche Produkte in ihrer Vielfalt kennen. Darüber hinaus werden Qualitätsmerkmale und ihre Erfassung in verschiedenen pflanzlichen Produkten und daraus hergestellten Lebensmitteln vorgestellt und die Studierenden lernen Produkte vergleichend zu bewerten. Weiterhin werden die Studierenden befähigt sich mit Fachvertretern über Informationen, Ideen, Probleme und Lösungen auszutauschen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Qualität pflanzlicher Produkte (Vorlesung) *Inhalte*: • Produktkunde zu pflanzlichen Produkten der gemäßigten Breiten u.a. Getreide, Kartoffeln, Zuckerrüben, Obst und Gemüse • Inhaltsstoffe und deren funktionelle Eigenschaften • Qualitätsmerkmale von pflanzlichen Produkten (Rohware) und daraus hergestellten Lebensmitteln • Qualitätsbeurteilung und Grundlagen der Lebensmittelanalytik	4 SWS
Prüfung: Klausur (60 Minuten) **Prüfungsanforderungen:** Darstellung der ganzheitlichen Produkteigenschaften und des Vorkommens und der funktionellen Eigenschaften von Inhaltsstoffen in pflanzlichen Produkten. Darstellung der Qualitätsmerkmale von pflanzlichen Produkten (Rohwaren) und daraus hergestellten Lebensmitteln und die analytische Beurteilung	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Susanne Neugart
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 120	

Georg-August-Universität Göttingen **Modul B.Agr.0421: Agrartechnik II - Vertiefungsmodul Agrartechnik / Außenwirtschaft** *English title: Agricultural Engineering II - Advanced Module Agricultural Engineering - Arable Farming*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erlernen vertiefte Kenntnisse über Maschinen, Geräte und technische Einrichtungen aus der Pflanzenproduktion und werden mit deren detailliertem Aufbau, Baugruppen und deren Funktionsweisen vertraut gemacht. Sie erlernen die komplexeren Zusammenhänge der betrachteten Technik, Berechnungsgrundlagen und deren Anwendung sowie ausgewählte vertiefte physikalische Zusammenhänge. Für ausgewählte Maschinen der Außenwirtschaft erlernen die Studierenden die Anwendung der Berechnungsgrundlagen und Methoden zur Überprüfung der Arbeitsqualität im praktischen Einsatz.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Agrartechnik II - Vertiefungsmodul Agrartechnik / Außenwirtschaft (Vorlesung, Übung) *Inhalte*: **Vorlesung** Das Modul vertieft die Grundlagen der Verfahrenstechnik in der Pflanzenproduktion. Zum Lehrinhalt gehören Details zu Aufbau und Funktionsweise von Landmaschinen, Motorentechnik, Antriebstechnik, Reifen / Fahrwerk, Ackerschlepper, Bodenbearbeitungs- und Sätechnik, Düngetechnik, Pflanzenschutztechnik und Erntetechnik sowie deren Einsatz. **Übung** In der Übung werden Kenntnisse zum Maschineneinsatz in der Außenwirtschaft an ausgewählten Beispielen vertieft. Die Studierenden erlernen u.a. verschiedene Methoden zur Überprüfung der Arbeitsqualität und deren Anwendung im praktischen Feldeinsatz.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Teilnahme an den Übungen (mind. 80 %) **Prüfungsanforderungen:** Vertiefte Kenntnisse zu Aufbau und Funktionsweise von Geräten und technischen Einrichtungen in der Pflanzenproduktion, Erkennen und Einordnen von technischen Zusammenhängen, Anforderungen an Technik für den Pflanzenbau und deren Umsetzung, ausgewählte Berechnungsgrundlagen, Anwendung physikalischer Grundlagen. Kenntnisse zum fachgerechten Einsatz der behandelten Maschinen der Außenwirtschaft und zur Bestimmung der Arbeitsqualität.	

Zugangsvoraussetzungen: B.Agr.0026	**Empfohlene Vorkenntnisse:** keine

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Frank Beneke
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4
Maximale Studierendenzahl: 48	

Bemerkungen: Für diese Lehrveranstaltung besteht Anwesenheitspflicht an mind. 80 % der Übungstermine.

Georg-August-Universität Göttingen **Modul B.Agr.0422: Agrartechnik III - Spezielle Themen der Agrartechnik** *English title: Agricultural Engineering III - Special Topics of Agricultural Engineering*	3 C 2 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen ausgewählte vertiefende Inhalte der Agrartechnik aus dem Bereich Ölhydraulik. Sie erlernen dabei die technischen Grundlagen, Methoden und Anwendungen aus dem o.g. Bereich. Das erworbene Wissen ermöglicht den Teilnehmern in diesen Themenfeldern technische Systeme zu analysieren, Problemstellungen zu erkennen und Lösungsvorschläge zu erarbeiten.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Agrartechnik III - Spezielle Themen der Agrartechnik (Vorlesung mit Übungen) *Inhalte*: **Vorlesung *Ölhydraulik*** Physikalische und technische Grundlagen der Ölhydraulik – Funktionselemente und Schaltungen – Anwendungen in der Agrartechnik – Aufbau von hydraulischen Systemen in der Agrartechnik – Lesen von Hydraulikschaltplänen **Laborübungen *Ölhydraulik*** Arbeitsweisen und Funktion von Hydraulikanlagen und -komponenten (z.B. Hydropumpen, Hydraulikzylinder, Hydromotoren und Ventile) in praktischen Anwendungen (Schaltungen) – Lesen von Hydraulikschaltplänen – Aufbau von Hydraulikanlagen nach Schaltplänen.	2 SWS
Prüfung: Klausur (60 Minuten) **Prüfungsvorleistungen:** Teilnahme an Übungsterminen (mind. 80 %) **Prüfungsanforderungen:** Kenntnisse in Anwendung physikalischer und technischer Grundlagen, Beschreibung hydraulischer Komponenten sowie kompletter hydraulischer Schaltungen, Anwendungen von Hydraulik in der Agrartechnik, grundlegende Berechnungen.	3 C

Zugangsvoraussetzungen: B.Agr.0421	**Empfohlene Vorkenntnisse:** B.Agr.0026
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Frank Beneke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 5
Maximale Studierendenzahl: 24	

Bemerkungen:

Für diese Lehrveranstaltung besteht Anwesenheitspflicht an mind. 80 % der Übungstermine.

Georg-August-Universität Göttingen **Modul B.Agr.0423: Chemische Übungen für Agrarwissenschaftler** *English title: Chemical Exercises for Agriculture Students*	6 C 6 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls sollten die Studierenden die grundlegenden und allgemeinen Prinzipien sowie Gesetzmäßigkeiten der allgemeinen anorganischen und organischen Chemie verstanden haben und über einen sicheren Umgang mit den Begrifflichkeiten der Chemie verfügen. Die Studierenden sollen die Arbeitsabläufe in chemischen Laboratorien erlernt haben, insbesondere Konzentrationen und Ausbeuten berechnen können, Lösungen ansetzen, Grundlagen der chemischen Reaktionsführung beherrschen sowie erste Einblicke in die Komplex- und Biochemie erhalten haben und die Prinzipien guter wissenschaftlicher Praxis beherrschen. Darüber hinaus sollte das sichere Arbeiten im Labor erlernt sein. Hierzu gehören Aspekte der Arbeitssicherheit, wie Geräte zur Brandbekämpfung, Flucht- und Rettungswege, Schutzkleidung im Labor und der sichere Umgang mit Gefahrstoffen. Dem Ziel folgend werden Experimente angeboten, die einen agrarwissenschaftlichen Bezug haben, wodurch die Inhalte in andere Fachgebiete überführt werden können.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Chemische Übungen für Agrarwissenschaftler (Praktikum) *Inhalte*: Elemente und Verbindungen, Aufbau der Materie, einfache Bindungskonzepte, chemische Gleichungen und Stöchiometrie, chemische Gleichgewichte, einfache Thermodynamik und Kinetik, Säure-Base-Reaktionen inklusive Puffer, Redoxreaktionen, Löslichkeit, einfache Elektrochemie, chemische Nomenklatur, Kohlenwasserstoffe, Aromaten, Addition-, Eliminierung- und Substitutionsreaktionen, funktionelle Gruppen, einfache Stereochemie, Isomerie, Kohlenhydrate, Aminosäuren, spektroskopische Methoden, Aspekte der Arbeitssicherheit mit agrarwissenschaftlichem Bezug	6 SWS
Prüfung: Ergebnisprotokoll inkl. Testate, unbenotet **Prüfungsvorleistungen:** regelmäßige und aktive Teilnahme am Praktikum, testierte Praktikumsprotokolle zu allen Praktikumsversuchen	6 C

Zugangsvoraussetzungen: B. Agr. 0025.1 - Chemie	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. nat. Susann Graupner
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 5
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Agr.0424: Datenmanagement und Angewandte Statistik in den Nutztierwissenschaften** *English title: Data Management and Applied Statistics in Animal Sciences*	6 C 4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Aneignung von Kompetenzen, die zur Abfassung einer experimentellen Bachelorarbeit sowie zu grundlegenden Datenanalysen mittels R befähigen. Die Studierenden sind in der Lage: • typische nutztierwissenschaftliche Fragestellungen als Hypothesen zu formulieren, • ein einfaches Experiment zu entwerfen (Auswahl der Variablen; Umfang der Stichprobe), • die Datenerhebung zu planen und konkret durchzuführen, • die Datenqualität zu beurteilen, • geeignete beschreibende bzw. schließende statistische Verfahren auszuwählen und in der Programmiersprache R umzusetzen, • geeignete Visulisierungsmethoden auszuwählen und anzuwenden, • Schlussfolgerungen aus den Ergebnisse statistischer Analysen ziehen, • Ergebnisse in den agrarwissenschaftlichen Kontext einzuordnen, • Analyseschritte und Ergebnisse zu dokumentieren und zu präsentieren,	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Datenmanagement und Angewandte Statistik in den Nutztierwissenschaften	4 SWS
Inhalte: • Planung eines Experiments inklusive Datenerhebung, • Zeitmanagement und Zusammenarbeit in Gruppen, • Qualitätskontrolle und Datenbereinigung, • Graphische Darstellung von Messwerten und Ergebnissen, • Grundlagen der Programmiersprache R, • Rekapitulation statistischer Konzepte (Korrelation, Assoziation, Regression, Statistisches Hypothesentesten), • mehrfaktorielle ANOVA mit Wechselwirkungen, post-hoc Tests, • Korrekturverfahren für multiples Testen, • nicht-parametrische Verfahren	
Prüfung: Klausur 50% der Prüfungsleistung (in der Mitte des Semesters): E-Prüfung 45 min., individuell (Verständnisfragen zu Statistik und Analyse von Datensätzen mit R) (45 Minuten)	3 C
Prüfung: Ausarbeitung und Präsentation - Gruppenarbeit (Analyse, Visualisierung und Ergebnispräsentation unter Einbeziehung des Quellcodes; ca. 15-20 min.) anhand von bereitgestellten Datensätzen (20 Minuten)	3 C

Prüfungsanforderungen: 50% der maximalen Punktzahl für das Bestehen	

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**

B.Agr.0013	keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Armin Schmitt
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 5
Maximale Studierendenzahl: 60	

Bemerkungen: Grundkenntnisse in R sind wünschenswert. Jede/r Teilnehmer/in sollte ein Notebook o.ä. zur Verfügung haben. Im Bedarfsfall kann ein Notebook gestellt werden.

Georg-August-Universität Göttingen **Modul B.Agr.0425: Datenmanagement, Versuchsplanung und graphische Darstellung mit Excel** *English title: Data Management, Experimental Design and Graphical Presentation with Excel*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen grundlegende und weiterführende Techniken in Excel. Selbstständiges Arbeiten und effizientes Anwenden von Excel mit Daten mit pflanzenbaulichem Bezug stehen im Vordergrund. Erlernt werden: • Anforderungen an das Datenmanagement zur anschließenden statistischen Auswertung in SAS oder R, • Erstellen klassischer Versuchsdesigns in EXCEL, • Interpretation statistischer Auswertungen, wie sie von SAS oder R erzeugt werden, • Graphische Gestaltung statistischer Auswertungen, wie sie von SAS oder R erzeugt werden, • Einfache angewandte statistische Auswertungen mit der Statistiksoftware SAS und R	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Datenmanagement, Versuchsplanung und graphische Darstellung mit Excel (Vorlesung, Übung) *Inhalte*: An großteils pflanzenbaulichen Beispielen werden Grundlagen für effizientes Arbeiten in Excel gelegt und weiterführende Techniken erarbeitet. • Eigenschaften von Variablen, • Strukturierung von Daten, Funktionen, • Filtern von Daten, • Graphische und tabellarische Ergebnisdarstellung, • Versuchsplanung, • Short-Cuts, • Einbinden von Graphiken in Word, • Beschriften und Beschreiben von Grafiken, • Statistische Maßzahlen, • Pivot-Tabellen	4 SWS
Prüfung: Praktische Prüfung (90 Minuten) **Prüfungsanforderungen:** Kenntnisse von grundlegenden und weiterführenden Techniken in Excel. Anlage von und Arbeiten mit strukturierten Daten. Einfache Randomisation von Versuchen. Graphische und tabellarische Ergebnisdarstellung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Christian Kluth

Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 5
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul B.Agr.0426: Methodische Grundlagen für empirische Forschung im Agribusiness** *English title: Basic Methods for Empirical Research in Agribusiness*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden (i) kennen die Breite der empirischen Forschungsmethoden im Bereich Agribusiness, (ii) sind in der Lage die Methoden anzuwenden und (iii) auf Fragestellungen des Agribusiness anzuwenden. Darüber hinaus vertiefen Studierende ihre Kenntnisse im Bereich wissenschaftliches Arbeiten und können in folgenden Haus-, Seminar- und Graduierungsarbeiten eigenständig die Methodenwahl für empirische Fragen begründen, diese anwenden und die Ergebnisse interpretieren	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Methodische Grundlagen für empirische Forschung im Agribusiness *Inhalte*: Die Lehrveranstaltung zielt auf eine ganzheitliche Methodenvermittlung im Bereich Agribusiness ab. Viele dieser Methoden werden in der Wissen- und in der Wirtschaft eingesetzt, so dass die erlernten Kompetenzen für wissenschaftsnahe sowie Tätigkeiten in der Praxis vorbereiten. Z.B. analysieren Großunternehmen zunehmend systematisch Märkte, Produkte und Kunden, so dass ein fundiertes Methodenwissen an Relevanz gewinnt. Die Vorlesung ist für Vorlesung und Übungen in mehreren Gruppen konzipiert und deckt folgende Inhalte ab: • Grundlagen Statistik für empirische Forschung im Agribusiness • Einführung in die Software R • Einführung in das wissenschaftliche Arbeiten • Konzipierung von Datenerhebungen in den Bereichen Sensorik- und experimentalökonomischer Forschung • Existierende Datensätze und deren Umgang damit im Bereich Agribusiness (z.B. Testbetriebsnetz) • Quantitative und qualitative Methoden zur Auswertung zur Beantwortung möglicher empirischer Forschungsfragen im Bereich der Sensorik- und Wirtschaftsforschung, u.a. uni- und multivariate Verfahren der Varianz- und Regressionsanalyse • Statistisches Hypothesentesten und statistische Inference	4 SWS
Prüfung: mündliche Gruppenpräsentation (max. 3 B.Agr.) à 10 Minuten einer Datenauswertung, inkl. Ergebnisinterpretation und Diskussion sowie einer Daten- & Auswertungsdokumentation max. 5 Seiten (50 %) **Prüfungsvorleistungen:** E-Klausur (60 Minuten; 50 %; im Semester, i.d.R. vor der Weihnachtspause)	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Agr.0013
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Silke Hüttel
Angebotshäufigkeit:	**Dauer:**

jedes Wintersemester	1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 5
Maximale Studierendenzahl: 70	

Georg-August-Universität Göttingen **Module B.Agr.0428: Introduction to Exploratory Data Analysis Using R**	6 C 4 WLH
Learning outcome, core skills: Students learn to apply a selected range of introduced methods for exploratory data analysis for agronomic research. They also gain skills in analyzing typical agricultural data using an open-source programming language (R) in the integrated development environment RStudio. Students will learn to interpret and present outputs from the analyses.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Introduction to exploratory data analysis using R (Lecture, Exercise) *Contents*: Elementary methods for analyzing agronomic datasets: Data types and scales; Managing, converting and aggregating data; Descriptive statistics; Graphing techniques; Basic and advance plotting (with ggplot2); Data distributions; Sample association prediction and regression models; and, Hypothesis testing.	4 WLH
Examination: Bi-weekly excercises (50%), Final written report (15 pages max., 50%) (max. 15 pages) **Examination requirements:** Students will solve in R a set of exercises and submit every two weeks. For the final report, a dataset will be provided to students with a number of tasks to be performed in R. Students are expected to analyze the data, summarise and interpret their results in the final written report. Basic knowledge of elementary methods of exploratory data analysis, and good skills in applying selected features of R to answer practical questions regarding agronomic and agri-environmental data.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Gennady Bracho Mujica
Course frequency: each winter semester1	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 15	

<table>
<tr><td>Georg-August-Universität Göttingen

Modul B.Agr.0429: Forschungsorientiertes Praktikum zur Qualitätsbewertung tierischer Erzeugnisse
English title: Research-oriented Practical Course on Quality Evaluation of Animal Products</td><td>6 C</td></tr>
<tr><td>Lernziele/Kompetenzen:
Die Studierenden erwerben v.a. laborpraktische Kenntnisse in grundlegenden Verfahren zur Qualitätsbewertung von Erzeugnissen tierischen Ursprungs. Das Modul vermittelt den Teilnehmer*innen dazu auch die notwendigen Fähigkeiten, um die im Labor durchgeführten Analyseverfahren korrekt zu beschreiben, Daten richtig auszudrücken, in den Kontext von Forschungsliteratur einzuordnen und zu präsentieren. Es werden Fähigkeiten zur Konzeption, Durchführung und Auswertung von Forschungsvorhaben vermittelt. Schlüsselkompetenzen wie Zeitmanagement, Kommunikation und Teamarbeit werden verbessert. Darüber erfolgen Unterweisungen in das sichere Arbeiten im Labor.</td><td>Arbeitsaufwand:
Präsenzzeit:
70 Stunden
Selbststudium:
110 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Forschungsorientiertes Praktikum zur Qualitätsbewertung tierischer Erzeugnisse (Blockveranstaltung, Exkursion, Übung, Laborpraktikum)
Inhalte:
Im Praktikum führen Studierende unter Anleitung verschiedene Labormethoden zur Bestimmung von physikalisch-chemischen Parametern zur Bewertung der Qualität von Produkten tierischen Ursprungs durch. Den Schwerpunkt bilden Fleisch, Milch und Eier.
• Fleisch: Bestimmung von z.B. pH-Wert, elektrischer Leitfähigkeit, Farbe, Scherkraft, Kochverlust, Bestimmung von TS- und Aschegehalt, nass-chemische IMF-Bestimmung, Tropfsaft- bzw. Lagerverlust; Fettsäuremuster, Histologie
• Eier: Bestimmung von inneren und äußeren Qualitätsparametern wie z.B. Eigewicht, Dotterfarbe, Schalendicke, Bruchfestigkeit, Frische, Einschlüsse;
• Milch und Milchprodukte: pH-Wert, titrierbarer Säuregehalt, Farbe, Textur, Feuchtigkeit, Asche usw
• Sensorische Bewertung von tier. Erzeugnissen
Begleitende Seminare vermitteln Inhalte rund um die Versuchsplanung, -auswertung und Ergebnisdiskussion mittels Fachliteratur. Die Exkursion zu Betrieben der Wertschöpfungskette tierischer Produkte vermittelt die praktische Relevanz und den Anwendungsbezug der Methoden. In Kleingruppen bearbeiten die Studierenden eine Fragestellung unter Anwendung der Labormethoden und erstellen dazu eine schriftliche Ausarbeitung bzw. Präsentation.</td><td>4 SWS</td></tr>
<tr><td>Prüfung: Praktikumsdokumentation (.pptx) inkl. Ergebnispräsentation (ca. 20 min.)
Prüfungsvorleistungen:
Regelmäßige Teilnahme an den Laborpraktika und der Exkursion.
Prüfungsanforderungen:
Korrekte Dokumentation der durchgeführten Analysen, Einordnung & Interpretation der erhaltenen Daten anhand von Vorlesungsinhalten und Fachliteratur.</td><td>6 C</td></tr>
</table>

Zugangsvoraussetzungen: Qualität tierischer Erzeugnisse (B Agr 0333)	**Empfohlene Vorkenntnisse:** Grundlagenkenntnisse in Chemie und Physik; Grundlagen in Mathematik & Statistik
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Daniel Mörlein
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** ab 5
Maximale Studierendenzahl: 12	

Bemerkungen:
Das Laborpraktikum und die Exkursion finden nach Ende der Vorlesungszeit im Wintersemester, typischerweise Ende Februar/Anfang März statt. Die Abgabe bzw. Präsentation des Berichtes erfolgt bis zum Ende des Wintersemesters (31.3.). Um sich für das Forschungspraktikum anmelden zu können, muss das Modul B Agr 0333 (Qualität tierischer Erzeugnisse) absolviert worden sein (inkl. Anmeldung zur Prüfung)

Georg-August-Universität Göttingen **Module B.Agr.0430: Food Systems and Healthy Diets**	6 C
Learning outcome, core skills: Students learn how food systems connect the decision on what we eat, how our food is produced, processed and distributed, with human health and planetary health outcomes. The course covers food systems in both low- and high-income countries. Students learn to engage in a critical debate on the role of food policies and other drivers in shaping our diets, and how this affects nutrition and health, the environment and the economy. Students learn to analyze these themes by engaging in basic data analysis and the critical analysis and exposition of arguments on relevant case studies and policies.	**Workload:** Attendance time: 0 h Self-study time: 180 h
Course: Food Systems and Healthy Diets *Contents*: This module introduces students to the global challenges of food security, nutrition, health and sustainability. It introduces the relevant concepts, analyses the drivers and policies that shape and can transform food systems. The module takes an interdisciplinary approach. Every lecture is accompanied by a more applied session in which case studies, specific themes or policies from lower, middle as well as high-income countries are discussed in more detail in an interactive way. Course material consists of presentations and lecture notes. A list of scientific reports, research articles and relevant data will be provided to students.	4 WLH
Examination: Written examinationWritten examination (60 minutes, 50%) (1)	3 C
Examination: Oral report with written elaboration Written examination (60 minutes, 50%) and paper and presentation (max. 10 pages, 50%) (max. 10 pages)	3 C
Examination requirements: Students are able to explain the concepts related to food systems, to analyse food policies, and to generate and interpret relevant statistics related to nutrition, food policies and global sustainability. In a written assignment, students provide a critical analysis of a specific food system and/or food policy intervention.	

Admission requirements: none	**Recommended previous knowledge:** Prior knowledge of microeconomics at BSc level is useful.
Language: English	**Person responsible for module:** Prof. Dr. Liesbeth Colen
Course frequency: each summer semester1	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**

Maximum number of students: 45	

Georg-August-Universität Göttingen **Modul B.Agr.0431: Planung und Auswertung experimenteller Bachelor-Arbeit in Nutzpflanzenwissenschaften** *English title: Planning and evaluation of experimental Bachelor thesis in crop sciences*	3 C 1 SWS

Lernziele/Kompetenzen: Eigenständige Planung und Auswertung von Versuchen im Bereich der Nutzpflanzenwissenschaften	**Arbeitsaufwand:** Präsenzzeit: 14 Stunden Selbststudium: 76 Stunden

Lehrveranstaltung: Planung und Auswertung experimenteller Bachelor-Arbeit in Nutzpflanzenwissenschaften (Tutorium) *Inhalte*: Die Studierenden erarbeiten unter Anleitung des Modulverantwortlichen anhand der geplanten Bachelor-Abschlussarbeit konkrete Versuchspläne (mit Excel möglich) und auf deren Grundlage die entsprechenden Datenstrukturen und die sich daraus ergebenden Auswertemethoden. Nach der Versuchsdurchführung werden unter Anleitung die Versuchsergebnisse mit SAS oder R ausgewertet, die Auswertestrategie und --schritte kommentiert und die Ergebnisse graphisch und tabellarisch präsentiert (in Excel möglich). Das Angebot richtet sich an Studierende der Fachrichtung Nutzpflanzenwissenschaften sowohl im Bachelor- als auch im Master-Studium, jedoch können Credits nur im Bachelor **oder** Master durch die Prüfungsleistung erworben werden. Unter Umständen kann sich das Modul auch auf in Praktika erhobene Daten beziehen und gewählt werden (siehe Zugangsvoraussetzungen). (Generell besteht für Studierende der Fachrichtung Nutzpflanzenwissenschaften das Angebot sich bei Fragen der Versuchsplanung und -auswertung an Dr. Christian Kluth zu wenden.) *Angebotshäufigkeit:* Nach Bedarf, Terminvergabe durch Modulverantwortlichen	
Prüfung: Hausarbeit **Prüfungsanforderungen:** Versuchsbeschreibung, strukturierte und klar beschriebene Daten und Randomisationsplan, lauffähiges, kommentiertes R- oder SAS-Skript, in dem die Auswertestrategie ausführlich beschrieben und begründet wird. Die Ergebnisbeschreibung, wie sie in der Bachelorarbeit dargestellt wird, ist nicht Teil der Bewertung, vielmehr mögliche alternative Darstellungsformen mit der entsprechenden Begründung der Darstellungsweise.	3 C

Zugangsvoraussetzungen: Vor Versuchsdurchführung muss die mögliche Anerkennung der Prüfungsleistung mit dem Modulverantwortlichen und der/dem BetreuerIn abgesprochen werden.	**Empfohlene Vorkenntnisse:** Routinierter Umgang mit Excel, Modul Datenmanagement, Versuchsplanung und graphische Darstellung mit Excel

Eine Anerkennung der Prüfungsleistung kann ohne vorherige Absprache der Versuchsplanung nur in Ausnahmefällen erfolgen.	
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Dr. Christian Kluth
Angebotshäufigkeit: Nach Bedarf, Terminvergabe durch Modulverantwortlichen	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 5 - 6
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Das Modul wird mit entsprechend höherer Erwartung (z.B. Fallzahlplanung, post hoc Poweranalyse, Modelselektion) auch im Master angeboten, jedoch kann das Modul nur einmal im gesamten Studiumsverlauf (zur Bachelor- bzw. Masterarbeit) angewählt werden.

Georg-August-Universität Göttingen **Modul B.Agr.0432: Digitale Pflanze – Pflanzenparameter messen** *English title: Digital Plant – Measuring plant parameters*	6 C 4 SWS
Lernziele/Kompetenzen: Das Modul lehrt die technischen Grundlagen der wichtigsten Messprinzipien aus dem Bereich der nicht-invasive Sensoren der Pflanzenwissenschaft für die Nutzung in Feld und im Gewächshaus. Im Fokus stehen dabei Sensortechnologien, die auf Skalenebenen wie einer Einzelpflanzen- und Plotskala eingesetzt und durch Verbindung mit mobilen Plattformen aus dem Bereich boden- und luftgestützte Robotik auch mit einem hohen Durchsatz angewendet werden können. Ausgewählte Sensoren der Fernerkundung und der Phänotypisierung sind beispielsweise RGB-Kameras, multi- und hyperspektrale Kameras, Thermograhie und 3D-Verfahren und stehen im Fokus der Vorlesung. Außerdem wird weiterführende Methodik zur Feldversuchsdurchführung zur Bewertung der Potentiale digitaler Technologien gelehrt. Zusätzlich ist die Messung von Referenzdaten, eine sensorspezifische Datenauswertung mit maschinellen Lernmethoden Inhalt des Moduls. Ein wesentlicher Fokus wird hierbei auf die Interpretation von Sensordaten mit agronomischem und pflanzenphysiologischem Wissen gelegt. Somit umspannt die Veranstaltung den gesamten Workflow zur digitalen Datenerfassung auf dem Feld unter Berücksichtigung aktueller Erkenntnisse aus der Forschung und Einbindung des digitalen Sensordatenmanagements. Anwendungsbeispiele aus dem Bereich der Erkennung, Identifikation und Quantifizierung von Unkrautvorkommen und Pflanzenkrankheiten insbesondere Blattkrankheiten werden präsentiert.	**Arbeitsaufwand:** Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden
Lehrveranstaltung: Digitale Pflanze – Pflanzenparameter messen (Vorlesung, Übung) *Inhalte*: Der Kurs lehrt ausgewählte Inhalte aus dem Bereich des digitalen Pflanzenmonitorings. Dabei werden a) Sensortechnologien aus der Fernerkundung und der Phänotypisierung gemeinsam mit b) Auswertungsmethoden der Messtechnik, der Informatik und maschinellen Lernverfahren kombiniert. Ein Hauptaugenmerk liegt dabei auf dem Erlernen der notwendigen Techniken zur selbständigen Datenaufnahme im Feld, inklusive einer vertieften Einführung in die Aufnahme von Referenzparametern und der Bonitur. Unterschiedliche Aspekte der digitalen Bonitur werden vermittelt und angewendet. Dies beinhaltet das Sammeln von weiteren Punktmessungen, die Analyse im Labor, sowie der Abgleich mit der manuellen Bonitur als Referenz zu Sensordaten. *Angebotshäufigkeit:* 1 Semester (1 Woche Blockmodul, 4 Messtermine, 1 Termin Abschlusspräsentation)	4 SWS

Prüfung: Analyse und Abgabe eines Datensatzes (max. 4 Seiten, 30%), Präsentation (ca. 10 Minuten, 30%), Hausarbeit (mx. 4 Seiten, 40%) **Prüfungsanforderungen:** Die Prüfungsleistung besteht aus drei Teilen: 1. die Aufbereitung, Analyse und Abgabe des Datensatzes mit aufgenommenen Felddaten (30%):2 Seiten Datenbeschreibung (Überblick, Datenformate, Zeitpunkte, Referenzdaten, 2 Seite Material und Methoden, Datenstruktur mit (Rohdaten, Arbeitsschritten, finaler Auswertung) in digitaler Form 2. die Präsentation der Daten und abgeleiteter Ergebnisse in einem 10minütigen Fachvortrag (ca. 10 Minuten, 30%) und 3. die schriftliche Ausarbeitung in Form einer Hausarbeit auf (max. 4 Seiten, 40%) Die schriftliche Ausarbeitung beinhaltet eine Einführung in die Fragestellung, die Methodik der Datenanalyse, sowie die Diskussion der Ergebnisse. Die Prüfungsleistung wird als Gruppenarbeit durchgeführt (max. 3 Personen)	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Anne-Katrin Mahlein
Angebotshäufigkeit: jedes Sommersemester1	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul B.Forst.1227: Ringvorlesung Agroforst** *English title: Lecture Series Agroforestry*	3 C 2 SWS

Lernziele/Kompetenzen: Ziel ist, dass die Studierenden ein vielfältiges Bild bekommen und die Kompetenz erwerben Informationen im Bereich Agroforstwirtschaft in komplexere Zusammenhänge einzuordnen, kritisch zu hinterfragen, sowie auf andere Kontexte zu übertragen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Ringvorlesung Agroforst (Vorlesung, Exkursion) *Inhalte*: Kennenlernen konkreter Beispiele von Agroforstsystemen, deren Auswirkungen auf Ökosystemfunktionen, sowie Herausforderungen und Erfolge beim Management anhand von Vorträgen aus Wissenschaft und Praxis. Das Modul wird in Kooperation mit der Agroforstgruppe Göttingen organisiert. *Literatur: Angabe wenn gewünscht*	2 SWS
Prüfung: Mündlich (ca. 15 Minuten)	3 C

Prüfungsanforderungen: Mündliche Prüfung zu den Inhalten der Ringvorlesung und der Exkursion zu wissenschaftlichen, praktischen sowie beraterischen Aspekten von Agroforstsystemen. Kritische Reflektion der Inhalte werden erwartet.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Franziska Leonie Gaede
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul B.WIWI-BWL.0098: Entrepreneurship und Innovation
English title: Entrepreneurship and Innovation</td><td>6 C
4 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Diese Veranstaltung sensibilisiert die Studierenden für unterschiedliche Formen von Entrepreneurship und die damit einhergehenden Potenziale und Herausforderungen. Dabei erlenen die Studierenden sowohl konzeptionelles als auch praktisches Wissen in Bezug auf Unternehmensgründung und Innovation. Das konzeptionelle Wissen befähigt sie, solche komplexen Situationen und Herausforderungen, mit welchen Entrepreneure sich häufig konfrontiert sehen, differenziert zu erfassen. Dies legt die Basis für die Auswahl geeigneter Werkzeuge zu deren Bewältigung. Die Studierenden werden somit befähigt, innovative Ideen zu generieren und mögliche unternehmerische Umsetzungsweisen zu evaluieren.</td><td>Arbeitsaufwand:
Präsenzzeit:
56 Stunden
Selbststudium:
124 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Entrepreneurship und Innovation (Vorlesung)
Inhalte:
Nicht nur in der Wirtschaft, sondern auch in der breiten politischen und gesellschaftlichen Öffentlichkeit gewinnen Entrepreneurship und Innovation zunehmend an Aufmerksamkeit und Bedeutung. Entrepreneure werden als zentrale Treiber von Innovation angesehen und sollen damit nicht nur zu wirtschaftlichem Wohlstand, sondern auch zur Bewältigung gesellschaftlicher Herausforderungen beizutragen. Wie kann man denn nun aber Innovation durch unternehmerisches Handeln vorantreiben?

Die Vorlesung ist sowohl wissenschaftlich fundiert als auch praxisnah gestaltet und umfasst zahlreiche interaktive, praktische Elemente.

Inhalte:
1. Was ist Entrepreneurship, was ist Innovation?
2. Wie können Ideen entwickelt werden?
3. Welchen Einfluss hat die Komposition der unternehmerischen Teams?
4. Welche Rolle spielen Netzwerke? Wie kann man sie bilden?
5. Wie identifiziert man Zielgruppen, Märkte, Wettbewerber?
6. Wie entwickelt man ein Geschäftsmodell, Business Plan, Business Model und Pitch Deck?
7. Wie kann man eine Unternehmensgründung finanzieren?
8. Welche regionalen Unterschiede prägen Entrepreneurship?</td><td>2 SWS</td></tr>
<tr><td>Lehrveranstaltung: Entrepreneurship und Innovation (Übung)
Inhalte:
Im Rahmen der begleitenden Übung vertiefen und erweitern die Studierenden die in der Vorlesung erworbenen Kenntnisse und Fähigkeiten.</td><td>2 SWS</td></tr>
<tr><td>Prüfung: Klausur (90 Minuten)
Prüfungsvorleistungen:
anwendungsbezogene Gruppenleistung (max. 10 Seiten oder ca. 15 Minuten Präsentation)</td><td>6 C</td></tr>
</table>

Prüfungsanforderungen: Die Studierenden erbringen den Nachweis, dass sie mit den Inhalten der Veranstaltung vertraut sind. Dies umfasst zum einen die Fähigkeit, wissenschaftliche Konzepte auf die Identifikation von Praxisprobleme anzuwenden, zum anderen die Kompetenz, eigenständig praktische Elemente aus dem Gründungsprozess voranzutreiben.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Katharina Scheidgen
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 6
Maximale Studierendenzahl: 45	

Bemerkungen: Die maximale Anzahl der Studierenden ergibt sich aufgrund der Bearbeitung von Fallstudien.

Georg-August-Universität Göttingen **Modul B.WIWI-BWL.0099: Entrepreneurial Projects** *English title: Entrepreneurial Projects*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden sind nach erfolgreicher Teilnahme des Moduls in der Lage eigenständig und in interdisziplinären Teams Projektprozesse im Bereich Entrepreneurship und Innovation zu planen und umzusetzen. Dabei werden sowohl klassische Managementmethoden wie Gantt-Diagramme, als auch agile Methoden wie Scrum genutzt. Die Organisation in Form von Arbeitspaketen, die Identifizierung von benötigten Ressourcen und das erfolgreiche Erreichen von Meilensteinen stehen im Vordergrund. Im Rahmen dieser Tätigkeiten arbeiten die Teilnehmenden im Team und nehmen unterschiedliche Teampositionen ein. Abschließend werden Möglichkeiten zur zielgruppenspezifischen Kommunikation der Projektergebnisse dargestellt und geübt, wie beispielsweise Pitches. Die Studierenden entwickeln ihre instrumentalen und systemischen Kompetenzen weiter und verbessern entscheidende, kommunikative Kompetenzen, um auch in hochgradig ungewissen Situationen, wie sie Innovationsprozesse und Entrepreneurship charakterisieren, kooperativ zusammenzuarbeiten und zu überzeugen. Indem die Studierenden an komplexen und praxisnahen Problemlösungen im Bereich Entrepreneurship und Innovation arbeiten, erweitern sie nicht nur ihre Fachkompetenzen, sondern auch ihre überfachlichen Kompetenzen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Entrepreneurial Projects (Projektseminar) *Inhalte*: Die Studierenden entwickeln eigene innovative Ideen, Gründungsprojekte, oder erarbeiten innovative Lösungen für Probleme bestehender Unternehmen mit unternehmerischen Methoden. Diese Projekte werden auf der Basis von Projektplänen kritisch hinterfragt. Dabei werden die Kernfunktionalitäten der möglichen Projektergebnisse herausgearbeitet und auf Prototypen angewendet. Falls möglich sollen potenzielle Anwender:innen aktiv in den Projektprozess eingebunden und Feedback eingeholt werden. **1. Projekt- und Prozessmanagement** Es werden klassische (z.B. Gantt-Diagramme) sowie agile Projektmanagement-Methoden (z.B. Scrum) behandelt. Darüber hinaus wird die Formulierung von Arbeitspaketen und die Entwicklung in Sprints Teil des Kurses sein. **2. Prototyping** Die Studierenden entwickeln Ideenskizzen und Testszenarien. Sie lernen Tools für den erfolgreichen Bau von Prototypen kennen und auszuwählen. Zudem lernen sie verschiedene Möglichkeiten zum Testen von Prototypen kennen. **3. Pitch Training** Im Pitch-Training werden zielgruppenspezifische Ansprachen von unterschiedlichen Stakeholder-Gruppen geübt. Es soll gezeigt werden, wie Kernbotschaften einfach	4 SWS

und unmissverständlich herausgearbeitet werden können. Der eigene Auftritt und das Präsentieren der Kernbotschaften stehen im Vordergrund der Veranstaltung.	
Prüfung: :Präsentation (ca. 5 Min., Pitch) und schriftliche Ausarbeitung (max. 15 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme	6 C

Prüfungsanforderungen: Die Präsentation ist in Form eines Pitches zu erbringen und umfasst folgende Bestandteile: Business Model Canvas, Pitch und Pitch-Deck. Ziel der Präsentation ist es, potenzielle Investor*innen und/ oder andere relevante Stakeholder zu überzeugen. Durch die schriftliche Ausarbeitung weisen die Studierenden nach, dass sie über methodisches Wissen verfügen, das hilft, eigenständig und im Team ‚entrepreneurial projects' zu planen und umzusetzen. Des Weiteren zeigen die Kursteilnehmenden anhand der zu prüfenden Leistung, dass sie die Zusammenhänge von einem in Arbeitspakten organisierten Projektprozess unter Einbeziehung der benötigten Ressourcen anhand einer Meilensteinkontrolle verstanden haben.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-BWL.0098 Entrepreneurship und Innovation
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Katharina Scheidgen
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 6
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul S.RW.1261: Vertragsgestaltung in der agrarrechtlichen Praxis** *English title: Drafting agricultural contracts*	6 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls „Vertragsgestaltung in der agrarrechtlichen Praxis“ • haben die Studierenden grundlegende Kenntnisse von den in einem landwirtschaftlichen Unternehmen gängigen Vertragsarten und Rechtsbereichen (Kaufrecht, landwirtschaftliches Erbrecht, Pachtrecht, Grundstücksverkehrsrecht, landwirtschaftliches Sozialversicherungsrecht, Beihilferecht sowie agrarproduktspezifische Regelungen) erlangt; • haben die Studierenden gelernt, die verschiedenen allgemeinen Fragen des Landpacht-, agrarspezifischen Kaufrechts, des Pacht- und Grundstückskaufrechts Vertragstypen zuzuordnen; • kennen die Studierenden die rechtlichen Grundlagen und Besonderheiten bei Liefer-, Anbau-, Kooperations- und Bewirtschaftungsverträgen, des Agrarsozialrechts und seine Auswirkungen auf die Vertragsgestaltung; • kennen die Studierenden die dogmatischen Konzeptionen der Vertragsgestaltung in ihrer systematischen, ideellen und praktischen Bedeutung; • kennen die Studierenden die Methoden der allgemeinen Vertragsgestaltung und deren Grundlagen sowie die damit im Zusammenhang stehenden spezifischen Praxisprobleme in der agrarrechtlichen Tätigkeit und können diese anwenden; • haben die Studierenden rechtliches Fachwissen und ein Grundverständnis für die ökonomischen und rechtlichen Themen und Problemstellungen in der Agrarwirtschaft anhand von Vertragsbeispielen und Fällen erlernt; • beherrschen die Studierenden die Fähigkeit, die im Rahmen einer agrarisch orientierten Tätigkeit oder in ihrem Beruf auftretenden juristischen Fragen einzuordnen, zu behandeln und zu beantworten. Sie haben gelernt, ein juristisches und ökonomisches Problembewusstsein im Bereich der Vertragsgestaltung zu entfalten sowie für juristische Probleme Lösungen zu entwickeln. • sind die Studierenden in der Lage, die erworbenen Kenntnisse bei der Lösung einschlägiger Fälle umzusetzen und sich mit den aufgeworfenen Rechtsfragen kritisch auseinanderzusetzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

Lehrveranstaltung: Vertragsgestaltung in der agrarrechtlichen Praxis (Vorlesung)	2 SWS
Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C

Prüfungsanforderungen: • grundlegende Kenntnisse im Agrarrecht und der agrarrechtlichen Vertragsgestaltung aufweisen,	

• ausgewählte Tatbestände der agrarrechtlichen Vertragsgestaltung beherrschen, • die zugehörigen methodischen Grundlagen beherrschen und • systematisch an einen agrarrechtlichen Fall zur Vertragsgestaltung herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul S.RW.1262: Grundlagen des Agrarrechts** *English title: Basics of agricultural law*	6 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls „Grundlagen des Agrarrechts " • haben die Studierenden Grundkenntnisse der agrarwirtschaftlich relevanten Bereiche des Rechts erlangt; (WTO-Recht, Europarecht, Verfassungsrecht, Verwaltungsrecht / Wirtschaftsverwaltungsrecht, , Eigentumsordnung der Landwirtschaft, Landwirtschaftliches Erbrecht, Landpachtrecht, Gesellschaftsrechtliche Formen bei landwirtschaftlichen Betrieben, Recht des ländlichen Raumes, Grundstückverkehrsrecht; Recht des Ländlichen Raums) • haben die Studierenden rechtliches Fachwissen und ein Grundverständnis für die ökonomische und soziale Bedeutung der Agrarwirtschaft und des Ländlichen Raums erlernt. Dazu gehören die juristische und ökonomische Fachsprache, der Umgang mit dem komplexen Normsystem des Agrarrechts und das Erkennen von Strukturzusammenhängen im Recht, • beherrschen sie die Fähigkeit, die im Rahmen einer agrarisch orientierten Tätigkeit oder ihres Berufes auftretenden juristischen Fragen zu erkennen und zu behandeln bzw. zu beantworten • sind die Studierenden in der Lage ein juristisches und ökonomisches Problembewusstsein zu entfalten sowie für juristische Probleme Lösungen zu entwickeln. Inhalte: I. Begriff des Agrarrechts II. Geschichte des Agrarrechts III. Rechtsquellen des Agrarrechts IV. Prinzipien des Agrarrechts V. Grundbegriffe des Agrarrechts 1. Landwirtschaft 2. Landwirt/in 3. Landwirtschaftlicher Betrieb VI. Landwirtschaft und Verfassung VII.Zivilrechtliche Sonderregelungen des landwirtschaftlichen Betriebes 1. Pachtrecht 2. Familien und Erbrecht 3. HGB	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

Lehrveranstaltung: Grundlagen des Agrarrechts (Vorlesung)	2 SWS
Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C

Prüfungsanforderungen: Durch die Modulprüfung weisen die Studierenden nach, dass sie • grundlegende Kenntnisse im Agrarrecht aufweisen, • ausgewählte Tatbestände des Agrarrechts beherrschen,	

• die zugehörigen methodischen Grundlagen beherrschen und • systematisch an einen agrarrechtlichen Fall herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul S.RW.1263: Europäisches Agrarrecht** *English title: European agricultural law*	6 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls „Europäisches Agrarrecht“ • haben die Studierenden Kenntnisse der agrarwirtschaftlich relevanten Bereiche des Europarechts erlangt; (Gemeinsame Agrarpolitik; Wettbewerbsrecht, insbesondere Kartellrecht; Umweltrecht) • haben die Studierenden rechtliches Fachwissen und ein Grundverständnis für das Zusammenspiel der verschiedenen Rechtsebenen, die die Agrarwirtschaft bestimmen entwickelt. Dazu gehören die juristische und ökonomische Fachsprache, der Umgang mit dem komplexen Normsystem des Agrarrechts und das Erkennen von Strukturzusammenhängen im Recht. • Sie beherrschen die Fähigkeit, die im Rahmen einer agrarisch orientierten Tätigkeit oder ihres Berufes auftretenden juristischen Fragen zu behandeln bzw. zu beantworten und hierfür ein juristisches und ökonomisches Problembewusstsein zu entfalten sowie für juristische Probleme Lösungen zu entwickeln. • kennen die Studierenden die dogmatischen Konzeptionen des europäischen Agrarrechts in ihrer systematischen, interdisziplinären und praktischen Bedeutung; • kennen die Studierenden die spezifischen Methoden der Gesetzesanwendung im Mehrebenensystem des öffentlichen Agrarrechts (Völker-, europa-, bundes- und landesrechtliche Ebene) und können diese anwenden; • sind die Studierenden in der Lage, die erworbenen Kenntnisse bei der Lösung einschlägiger Fälle umzusetzen und sich mit den aufgeworfenen Rechtsfragen kritisch auseinanderzusetzen. Inhalte: I. Die Bedeutung der Landwirtschaft und der Fischerei in der EU II. Agrarrecht im Europäischen Primärrecht III. Die Gemeinsame Agrarpolitik IV. Der Anwendungsbereich der Gemeinsamen Agrarpolitik (GAP) und der Gemeinsamen Fischereipolitik (GFP) V. Die Entwicklung der GAP VI. Wirtschaftsvölkerrechtlicher Rahmen VII. Die Ziele der GAP VIII.Die Säulen der GAP 1. Gemeinsame Marktorganisation 2. Die Entwicklung des ländlichen Raumes IX. Das Verhältnis der GAP zu anderen EU- Politiken X. Die Gemeinsame Fischereipolitik (GFP) XI. Kontrolle	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden
Lehrveranstaltung: Europäisches Agrarrecht (Vorlesung)	2 SWS
Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C

Prüfungsanforderungen: Durch die Modulprüfung weisen die Studierenden nach, dass sie • grundlegende Kenntnisse im europäischen Agrarrecht aufweisen, • ausgewählte Tatbestände des europäischen Agrarrechts beherrschen, • die zugehörigen methodischen Grundlagen beherrschen und • systematisch an einen Fall aus dem europäischen Agrarrechts herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul S.RW.1264: Agrarumweltrecht** *English title: Law of the agricultural environment*	6 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls "Agrarumweltrecht" • haben die Studierenden Kenntnisse in den für die Landwirtschaft relevanten Bereichen des Umweltrechts erlangt; • kennen die Studierenden die dogmatischen Konzeptionen des Agrarumweltrechts in ihrer systematischen, interdisziplinären und praktischen Bedeutung; • kennen die Studierenden die spezifischen Methoden der Gesetzesanwendung im Mehrebenensystem) des Agrarumweltrechts (Völker-, europa-, bundes und landesrechtliche Ebene) und können diese anwenden; • sind die Studierenden in der Lage, die erworbenen Kenntnisse bei der Lösung einschlägiger Fälle umzusetzen und sich mit den aufgeworfenen Rechtsfragen kritisch auseinanderzusetzen. Inhalte: 1. Teil: Rechtsquellen des Umweltrechts • Umweltrecht des Bundes und der Länder • Umweltvölkerrecht • Europäisches Umweltrecht 2. Teil: Allgemeines Umweltrecht • Prinzipien des Umweltrechts • Instrumente des Umweltrechts • Mediation • Umweltverfassungsrecht • Umweltverwaltungsrecht • Rechtsschutz im Umweltrecht 3. Teil: Besonderes Umweltrecht • Immissionsschutzrecht • Raumordnungs- und Landesplanungsrecht • Tierschutzrecht • Gewässerschutzrecht • Bodenschutzrecht • Gefahrstoffrecht • Gentechnikrecht • Umwelthaftungsrecht • Energierecht • Klimaschutzrecht	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden
Lehrveranstaltung: Agrarumweltrecht (Vorlesung)	2 SWS

Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C

Prüfungsanforderungen: Durch die Modulprüfung weisen die Studierenden nach, dass sie • grundlegende Kenntnisse im Agrarumweltrecht aufweisen, • ausgewählte Tatbestände des Agrarumweltrecht beherrschen, • die zugehörigen methodischen Grundlagen beherrschen und • systematisch an einen Fall aus dem Agrarumweltrecht herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul S.RW.1265: Agrarverwaltungsrecht** *English title: Agricultural administrative law*	6 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls „Agrarverwaltungsrecht“ • haben die Studierenden Kenntnisse der agrarwirtschaftlich relevanten Bereiche des Verwaltungsrechts (Verwaltungsrecht / Wirtschaftsverwaltungsrecht, , Eigentumsordnung der Landwirtschaft, Landpachtrecht, Gesellschaftsrechtliche Formen bei landwirtschaftlichen Betrieben, Recht des ländlichen Raumes, Grundstückverkehrsrecht, Recht des Ländlichen Raums) und dessen Einbindung in das rechtliche Mehrebenensystem erlangt. • haben die Studierenden rechtliches Fachwissen und ein Grundverständnis für die ökonomische und soziale Bedeutung der Agrarwirtschaft und des Ländlichen Raums erlernt. Dazu gehören die juristische und ökonomische Fachsprache, der Umgang mit dem komplexen Normsystem des Agrarrechts und das Erkennen von Strukturzusammenhängen im Recht. • haben die Studierenden Kenntnisse im öffentlichen Agrarrecht und insbesondere in den für die Landwirtschaft relevanten Bereichen des Verwaltungsrechts erlangt; • kennen die Studierenden die dogmatischen Konzeptionen des Agrarverwaltungsrechts in ihrer systematischen, interdisziplinären und praktischen Bedeutung; • kennen die Studierenden die spezifischen Methoden der Gesetzesanwendung (im Mehrebenensystem) des öffentlichen Agrarrechts ; • sind die Studierenden in der Lage, die erworbenen Kenntnisse bei der Lösung einschlägiger Fälle umzusetzen und sich mit den aufgeworfenen Rechtsfragen kritisch auseinanderzusetzen. Inhalte: I. Landwirtschaft als Adressatin der Verwaltung II. Agrarverwaltungsrecht als besonderes öffentliches Wirtschaftsrecht III. Verfassungsrechtliche Grundlagen IV. Europarechtlicher Rahmen V. Ausgewählte Bereiche 1. Baurecht 2. Grundstückverkehrsrecht 3. Wettbewerbsrecht 4. Gewerbeordnung 5. Steuerrecht 6. Sozialrecht	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden
Lehrveranstaltung: Agrarverwaltungsrecht (Vorlesung)	2 SWS
Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C
Prüfungsanforderungen: Durch die Modulprüfung weisen die Studierenden nach, dass sie • grundlegende Kenntnisse im Agrarverwaltungsrecht aufweisen,	

• ausgewählte Tatbestände Agrarverwaltungsrechts beherrschen, • die zugehörigen methodischen Grundlagen beherrschen und • systematisch an einen Fall aus dem Agrarverwaltungsrecht herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul S.RW.1276: Agrarrecht vor Gericht** *English title: Agricultural law in court*	6 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls „Agrarrecht vor Gericht“ • haben die Studierenden grundlegende Kenntnisse über die einzelnen Rechtswege und die jeweiligen Prozessgrundsätze der im Agrarrecht einschlägigen Gerichtsverfahren erlangt; • haben die Studierenden einen guten Überblick über die im materiellen Agrarrecht auftretenden Fragestellungen (Landpacht, landw. Erbrecht; Grundstücksverkehr; Baurecht ;) • kennen die Studierenden die rechtlichen Tierschutz Grundlagen und Besonderheiten der Verfahren vor den Landwirtschaftsgerichten und anderen agrarrelevanten Gerichten • haben die Studierenden rechtliches Fachwissen und ein Grundverständnis für die ökonomischen und rechtlichen Themen und Problemstellungen in der Agrarwirtschaft anhand von Beispielen und Fällen erlernt; • beherrschen die Studierenden die Fähigkeit, die im agrarischen Kontext auftretenden juristischen Fragen unterschiedlichen Rechtswegen und Verfahrensarten zuzuordnen, sie zu bewerten und zu beantworten. Sie haben ein juristisches und ökonomisches Problembewusstsein im Zusammenhang mit gerichtlichen Verfahren entwickelt sowie die Fähigkeit für juristische Probleme Lösungen zu entwickeln; • sind die Studierenden in der Lage, die erworbenen Kenntnisse bei der Lösung einschlägiger Fälle umzusetzen und sich mit den aufgeworfenen Rechtsfragen kritisch auseinanderzusetzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

Lehrveranstaltung: Agrarrecht vor Gericht (Vorlesung) *Angebotshäufigkeit:* jedes Sommersemester	
Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C

Prüfungsanforderungen: • Grundlegende Kenntnisse im Agrarrecht und des agrarrechtlich relevanten Verfahrensrechts aufweisen, • ausgewählte Tatbestände des agrarrechtlich relevanten Zivil- und Verwaltungsverfahrensrechts beherrschen, • die zugehörigen methodischen Grundlagen beherrschen und systematisch an einen agrarrechtlichen Fall agrarrechtlich relevanten Verfahrensrechts herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria

Angebotshäufigkeit: 1	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Fakultät für Agrarwissenschaften:

Nach dem Beschluss des Fakultätsrats der Fakultät für Agrarwissenschaften vom 21.12.2023 hat das Präsidium der Georg-August-Universität Göttingen am 31.01.2024 die Neufassung des Modulverzeichnisses zur Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang „Agrarwissenschaften“ genehmigt (§ 44 Abs. 1 Satz 2 NHG, §§ 37 Abs. 1 Satz 3 Nr. 5 b), 44 Abs. 1 Satz 3 NHG).

Georg-August-Universität
Göttingen

Modulverzeichnis

für den konsekutiven Master-Studiengang "Agrarwissenschaften" - zu Anlage 1 der Prüfungs- und Studienordnung für Master-Studiengänge der Fakultät für Agrarwissenschaften (Amtliche Mitteilungen I Nr. 26/2023 S. 845)

Module

Übersicht nach Modulgruppen

I. Master-Studiengang "Agrarwissenschaften"

Es müssen Leistungen im Umfang von insgesamt wenigstens 120 C erfolgreich absolviert werden.

1. Studienschwerpunkte

Es muss ein Studienschwerpunkt im Umfang von insgesamt 60 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

a. Schwerpunkt "Agribusiness"

aa. Block A

Es müssen 3 der folgenden Wahlpflichtmodule im Umfang von insgesamt 18 C erfolgreich absolviert werden.

bb. Block B

Es müssen 5 der folgenden Wahlpflichtmodule im Umfang von insgesamt wenigstens 30 C erfolgreich absolviert werden.

cc. Block C

Es müssen insgesamt 12 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Block C1

Es muss eines der folgenden Module im Umfang von 6 C erfolgreich absolviert werden:

ii. Block C2

Es muss eines der folgenden Module im Umfang von 6 C erfolgreich absolviert werden:

b. Schwerpunkt "Nutzpflanzenwissenschaften"

aa. Block A

Es müssen 3 der folgenden Wahlpflichtmodule im Umfang von insgesamt 18 C erfolgreich absolviert werden.

bb. Block B

Es müssen 5 der folgenden Wahlpflichtmodule im Umfang von insgesamt wenigstens 30 C erfolgreich absolviert werden.

cc. Block C

Es müssen die 2 folgenden Wahlpflichtmodule (Bereich Schlüsselkompetenzen) im Umfang von insgesamt 12 C erfolgreich absolviert werden.

c. Schwerpunkt "Nutztierwissenschaften"

aa. Block A

Es müssen 3 der folgenden Wahlpflichtmodule im Umfang von insgesamt 18 C erfolgreich absolviert werden.

bb. Block B

Es müssen 5 der folgenden Wahlpflichtmodule im Umfang von insgesamt 30 C erfolgreich absolviert werden.

cc. Block C

Ferner müssen die 2 folgenden Wahlpflichtmodule (Bereich Schlüsselkompetenzen) im Umfang von insgesamt 12 C erfolgreich absolviert werden.

d. Schwerpunkt "Ressourcenmanagement"

aa. Block A

Es müssen 3 der folgenden Wahlpflichtmodule im Umfang von insgesamt 18 C erfolgreich absolviert werden.

bb. Block B

Es müssen 5 der folgenden Wahlpflichtmodule im Umfang von insgesamt wenigstens 30 C erfolgreich absolviert werden.

cc. Block C

Ferner müssen die 2 folgenden Wahlpflichtmodule (Bereich Schlüsselkompetenzen) im Umfang von insgesamt 12 C erfolgreich absolviert werden.

e. Schwerpunkt "Wirtschafts- und Sozialwissenschaften des Landbaus"

aa. Block A

Es müssen die 3 folgenden Wahlpflichtmodule im Umfang von insgesamt 18 C erfolgreich absolviert werden.

bb. Block B

Es müssen 5 der folgenden Wahlpflichtmodule im Umfang von insgesamt wenigstens 30 C erfolgreich absolviert werden.

cc. Block C

Es müssen insgesamt 12 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden.

i. Block C1

Es muss das folgende Modul im Umfang von 6 C erfolgreich absolviert werden:

ii. Block C2

Es muss eines der folgenden Module im Umfang von 6 C erfolgreich absolviert werden:

2. Block D - Fachwissenschaftliche Wahlpflichtmodule

Es müssen weitere 5 Module im Umfang von insgesamt wenigstens 30 C aus dem Lehrangebot eines Schwerpunktes dieses Master-Studienganges, eines anderen Master-Studienganges der Fakultät für Agrarwissenschaften in Göttingen oder einer entsprechenden anderen agrarwissenschaftlichen Fakultät oder aus verwandten Studiengängen erfolgreich abgeschlossen werden. Eine ergänzende Auswahl an möglichen Modulen findet sich im Vorlesungsverzeichnis (eCampus/EXA) unter „optionale Block – D Veranstaltungen“.

3. Masterarbeit

Durch die erfolgreiche Anfertigung der Masterarbeit werden 24 C erworben.

4. Kolloquium zur Masterarbeit

Durch das erfolgreiche Absolvieren des Kolloquiums zur Master-Arbeit werden 6 C erworben.

II. Modulpaket "Agrarwissenschaften"

Zugangsvoraussetzungen

Das Modulpaket „Agrarwissenschaften" im Umfang von 36 C kann nur studieren, wer im Verlauf des vorhergehenden Studiengangs mindestens 30 C aus dem Bereich der Agrarwissenschaften nachweisen kann.

Modulübersicht

Es müssen Module im Umfang von insgesamt 36 C aus nachfolgendem Angebot erfolgreich absolviert werden; soweit diese sämtlich in einem der Studiengebiete "Agarökonomie", "Nutzpflanze" und "Nutztier" erbracht werden, kann dies zusätzlich zertifiziert werden:

1. Studiengebiet "Agrarökonomie"

2. Studiengebiet "Nutztier"

3. Studiengebiet "Nutzpflanze"

III. Joint Degree (optional) „International Master of Science in Soils and Global Change“

Es müssen 120 C nach Maßgabe der nachfolgenden Bestimmungen erworben werden.

1. Erster Studienabschnitt (1.und 2. Semester)

Es müssen Module des ersten Studienabschnitts im Umfang von insgesamt 60 C an der Universiteit Gent (Gent, Belgien), der Aarhus Universitet (Aarhus, Dänemark) und/oder der Universität für Bodenkultur Wien (Wien, Österreich) nach Maßgabe der dort geltenden prüfungsrechtlichen Bestimmungen erfolgreich absolviert werden.

2. Zweiter Studienabschnitt A (3. Semester)

Studierende, die die Spezialisierung „Soil Biogeochemistry and Global Change“ gewählt haben, verbringen ihr drittes Semester an der Universität Göttingen und müssen Module im Umfang von insgesamt 30 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolvieren.

a. Pflichtmodule

Es müssen nachfolgende Module im Umfang von insgesamt 18 C erfolgreich absolviert werden:

b. Wahlpflichtmodule

Es müssen nachfolgende Module im Umfang von insgesamt 12 C erfolgreich absolviert werden:

3. Zweiter Studienabschnitt B

Studierende, die im Rahmen der Spezialisierung „Soil Biogeochemistry and Global Change“ ihre Masterarbeit an der Universität Göttingen verfassen und müssen folgende Leistungen erfolgreich absolvieren.

a. Masterarbeit

Durch die erfolgreiche Anfertigung der Masterarbeit werden 30 C erworben.

Georg-August-Universität Göttingen **Modul B.WIWI-VWL.0007: Einführung in die Ökonometrie** *English title: Introduction to Econometrics*	6 C 6 SWS
Lernziele/Kompetenzen: Das Modul gibt eine umfassende Einführung in die ökonometrische Analyse ökonomischer Fragestellungen. Die Studierenden erlernen mit Hilfe der Methoden linearer Regressionsanalyse erste eigene empirische Studien durchzuführen. Die vermittelten Kompetenzen beinhalten die Spezifikation von ökonometrischen Modellen, die Modellselektion und –schätzung. Darüber hinaus werden Studierende mit ersten Problemen im Bereich der linearen Regression wie beispielsweise Heteroskedastizität und Autokorrelation vertraut gemacht. Dieses Modul bildet das Fundament für weiterführende Ökonometrie Veranstaltungen.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Einführung in die Ökonometrie (Vorlesung) *Inhalte*: 1. Einführung in lineare multiple Regressionsmodelle, Modellspezifikation, KQ-Schätzung, Prognose und Modellselektion, Multikollinearität und partielle Regression. 2. Lineares Regressionsmodell mit normalverteilten Störtermen, Maximum-Likelihood-Schätzung, Intervallschätzung, Hypothesentests 3. Asymptotische Eigenschaften des KQ- und GLS Schätzers 4. Lineares Regressionsmodell mit verallgemeinerter Kovarianzmatrix, Modelle mit autokorrelierten und heteroskedastischen Fehlertermen, Testen auf Autokorrelation und Heteroskedastizität.	2 SWS
Lehrveranstaltung: Einführung in die Ökonometrie (Übung) *Inhalte*: Die Großübung vertieft die Inhalte der Vorlesung anhand von Rechenaufgaben mit ökonomischen Fragestellungen und Datensätzen. Weiterhin werden theoretische Konzepte aus der Vorlesung detailliert hergeleitet.	2 SWS
Lehrveranstaltung: Einführung in die Ökonometrie (Tutorium) *Inhalte*: Das Tutorium vertieft die Inhalte der Vorlesung und Großübung anhand von Rechenaufgaben. Ein großer Teil beinhaltet das Schätzen von ökonometrischen Modellen mit realen Daten und mit Hilfe des Softwareprogramms Eviews.	2 SWS
Prüfung: Klausur (90 Minuten)	6 C
Prüfungsanforderungen: Die Studierenden zeigen, dass sie einfache ökonometrische Konzepte verstanden haben. Darüber hinaus sind sie in der Lage, diese auf reale wirtschaftliche Fragestellungen anzuwenden.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-OPH.0002 Mathematik B.WIWI-OPH.0006 Statistik

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Helmut Herwartz
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 5
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Module M.Agr.0001: Practical Course in Agronomy**	6 C 4 WLH
Learning outcome, core skills: The students learn how to use information obtained by measurements and observations to parameterize, calibrate and validate crop growth simulation models. Students learn to perform phenological observations and measurements of relevant plant growth processes at organ, plant and canopy level. In addition, measurements of agro-climatic variables at (automated weather) stations and of soil characteristics are introduced.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Practical course in agronomy (Exercise, Seminar) *Contents*: Determining phenological development stages, leaf area index, chlorophyll content, photosynthetic light curves,radiation interception by the canopy, leaf gas exchange, organ and canopy temperature, soil physical properties, soil moisture, soil temperature, soil respiration, Nmin, weather station measurements(air temperature and humidity, precipitation, wind, irradiation)above-ground biomass, yield and yield components; introduction to operational crop growth modelling, parameterization, calibrationand validation of the crop models.	4 WLH
Examination: 3 Protocols (max. 10 pages) **Examination prerequisites:** Regular attendance at the exercises **Examination requirements:** Detailed knowledge of major plant growth and soil physical processes and yield determining factors, basic knowledge about crop growth modelling, processes considered in widely applied models and methods for model parameterization and evaluation. The protocols can be prepared in either German or English.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Siebert
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 12	

Georg-August-Universität Göttingen **Module M.Agr.0003: Agribusiness Sugar Beet- an advanced education for graduate students and junior employees of the sugar supply chain (English)**	6 C
Learning outcome, core skills: • profound knowledge in the following fields of the sugar value chain: breeding and other upstream sectors, technology of the sugar and bioethanol industry and biogas production, other downstream sectors, sugar market, agricultural policy • detailed identification of causal relationships in the process management on the basis of recent scientific knowledge • knowledge enhancement by interpreting scientific figures and tables and their statistics • opportunity of an advanced education particularly suitable as an on-the-job training program • opportunity to develop a professional network with other graduate students and external participants from different professional backgrounds and sugar beet growing areas worldwide	**Workload:** Attendance time: 54 h Self-study time: 126 h
Course: Agribusiness Sugar Beet - an advanced education for graduate students and junior employees of the sugar supply chain (English) (Block course, Lecture, Excursion) *Contents*: In comparison to other cash crops the refining of sugar from sugar beet is characterized by a considerable degree of cooperation between agriculture and food industry. Consequently all specific impacts of the entire production chain of sugar from beet are covered by this module as there are plant breeding, soil cultivation, growing impacts from sowing to harvest including all technical and cultivation aspects, crop yield, extension services, weed control, pathogen and pest management, precision agriculture, as well as definition and analysis of the technical quality, processing technology of sugar beets, logistics of harvest and transportation, global trade, sugar as food and its marketing. The module consists of lectures by invited speakers and lecturers of the Institute of Sugar Beet Research, work shops, field trips and excursion.	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Knowledge of the sugar value chain and understanding of different influences on the system on the basis of the latest scientific insights.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Anne-Katrin Mahlein
Course frequency: each summer semester	**Duration:** 2 Weeks

Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen Module M.Agr.0005: Crop Production and Grassland Management	6 C 4 WLH
Learning outcome, core skills: The students learn to analyze and discuss traditional and actual problems in crop and grassland science. In seminars, students critically review articles about on current agronomic research questions and discuss their evaluation report with other students.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Allgemeiner Pflanzenbau und Graslandwirtschaft (Lecture) *Contents*: Principles of sustainable agricultural land use, nutrient supply and soil conservation, crop rotations, plant growthand yield formation, phenological development, water and energy balances in crops and grassland, yield determining factors, crop and pasture management, resource use efficiency, analysis of agricultural systems, competition and symbiosis, quality of harvested productsReview: criteria for evaluating scientific articles, presentation of an own review of a research article and discussion of the reviewwith the other students and the lecturers.	4 WLH
Examination: Written exam (45 minutes; 65%) and term paper (max. 5 pages; 35%) **Examination requirements:** Advanced knowledge of plant development and growth processes, of resource use and resource use efficiencies in plant production systems and of the impacts of abiotic and biotic stress factors on plant canopies, basic knowledge in systems analysis, detailed knowledge of principles of the scientific practice and of criteria for scientificresearch, basic knowledge about article writing and article reviewing. The exam will be bi-lingual (German + English). The term paper can be prepared in either German or English.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Siebert
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 50	

Georg-August-Universität Göttingen **Modul M.Agr.0007: Aquakultur 2** *English title: Aquaculture 2*	6 C 5 SWS
Lernziele/Kompetenzen: Die Studierenden verfügen über eine vertiefte Ausbildung in den Bereichen der Aquakultur, die an der Fakultät für Agrarwissenschaften im Besonderen wissenschaftlich bearbeitet werden. Sie sind in der Lage sich selbständig neues Wissen anzueignen, dieses in klarer und eindeutiger Weise gegenüber Fachvertretern und Laien zu vermitteln und es zu aktuellen Problemlösungen anzuwenden.	**Arbeitsaufwand:** Präsenzzeit: 68 Stunden Selbststudium: 112 Stunden
Lehrveranstaltung: Aquakultur 2 (Vorlesung, Übung, Seminar) *Inhalte*: Zentrale Inhalte sind die Leistungsprofile und Entwicklungsmöglichkeiten der wichtigsten Aquakulturkandidaten, die Züchtung von Fischen unter besonderer Berücksichtigung genomveränderter Züchtungstechnik, die Produktionstechnologie in Wasserkreislaufanlagen, spezielle Aspekte der Fischernährung und Produktqualität, der Reproduktion von Fischen, der Hygiene in der Aquakultur sowie der Auswirkungen der Fischkulturen auf Ökologie der Wasserkörper einschließlich Abwasserklärung.	5 SWS
Prüfung: Mündlich (ca. 25 Minuten) **Prüfungsvorleistungen:** Vortrag (ca. 15 Minuten) über ein Thema aus der Auqakultur, Vortrag wird im laufenden Modul gehalten **Prüfungsanforderungen:** Ausführliche Kenntnisse aus der Kreislauftechnologie, inklusive relevanter Fischkandidaten, Züchtungstechnik, Produktkunde inklusive Qualitätsaspekten und Hygiene	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Simon Rosenau
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Modul M.Agr.0008: Mikro- und Wohlfahrtsökonomie** *English title: Microeconomics and Welfare Economics*	6 C 6 SWS

Lernziele/Kompetenzen: Teilmodul 1: Mikroökonomie Die Studierende erwerben Kenntnisse über mikroökonomische Modellansätze zur Analyse von wichtigen Problemen in der Volkswirtschaft. Sie erlernen die grundlegende Vorgehensweise eigenständiger mikroökonomischer Analyse, basierend auf formaler Modellanalyse. Sie können die Bedeutung von Annahmen für die Ergebnisse und Voraussagen mikroökonomischer Analyse. Sie erwerben die notwendigen Fähigkeiten, um aus der Theorie abgeleitete Hypothesen mit empirischen Daten zu konfrontieren, so dass diese Kenntnisse in weiteren quantitativ orientierten Modulen weiterverwendet werden können. Teilmodul 2: Wohlfahrtsökonomie • die Studierenden erkennen, warum es sinnvoll ist, soziale Probleme als Knappheitsprobleme zu analyisieren, • lernen, welche Vorteile es hat, diese Probleme mit Hilfe von Wettbewerbsprozessen zu bewältigen, • lernen, auf welcher Grundlage wirtschaftspolitische Empfehlungen basieren.	**Arbeitsaufwand:** Präsenzzeit: 96 Stunden Selbststudium: 84 Stunden

Lehrveranstaltung: Mikroökonomie (Vorlesung, Übung) *Inhalte*: In der Lehrveranstaltung „Mikrotheorie" werden die Grundlagen der quantitativen Analyse der ökonomischen Theorie des Verhaltens von Verbauchern und Produzenten sowie der Theorie der Preisbildung bei unvollkommenem Wettbewerb behandelt.	4 SWS
Prüfung: Klausur (45 Minuten) **Prüfungsanforderungen:** Der Lehrinhalt von Mikroökonomie wird in einer Klausur geprüft, die zum Bestehen des Gesamtmoduls mit einer Note von 4 oder besser bestanden sein muss. Abprüfbare Lerneinheiten umfassen: Grundlegende Kenntnisse der Preisbildung im Monopol, gesamtwirtschaftlicher Optimumsbedingungen, konjekturaler Variationen im Duopol und primaler Abbildung der Technologie: Produktionsfunktion; Dualität: Kosten- und Gewinnfunktionen; Präferenzen und Nutzenmaximierung; Dualität: Ausgaben- und indirekte Nutzenfunktion; Schätzung von Nachfragegleichungssystemen	3 C

Lehrveranstaltung: Wohlfahrtsökonomie (Vorlesung) *Inhalte*: • Theoretische Wohlfahrtsökonomie • Potentielle PARETO-Verbesserungen, PARETO-Verbesserungen und PARETO-Optima • Wohlfahrtsmaße	2 SWS

• Angewandte Wohlfahrtsökonomie • Volkswirtschaftliche Projektbewertung: Kosten-Nutzen-Rechnung • Volkswirtschaftliche Politikanalyse I: Bewertungsverfahren für ungestörte Märkte • Volkswirtschaftliche Politikanalyse II: Bewertungsverfahren für gestörte Märkte	
Prüfung: Klausur (45 Minuten) **Prüfungsanforderungen:** Der Lehrinhalt von Wohlfahrtsökonomie wird in einer Klausur geprüft, die zum Bestehen des Gesamtmoduls mit einer Note von 4 oder besser bestanden sein muss. Abprüfbare Lehrinhalte umfassen: Paretianische Marginal- und Totalbedingungen in einer geschlossenen und offenen Volkswirtschaft, First Best und Second Best Schattenpreise, Kompensierende Äquivalente Variation, Bewertung von Investitionsprojekten, Bewertung von Preisänderungen	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Bernhard Brümmer
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Module M.Agr.0009: Biological Control and Biodiversity**	6 C 6 WLH
Learning outcome, core skills: Gain an understanding of what biological control is and how it can be used effectivelyas part of an IPM system and how biodiversity contributes to control of pest populations and other ecosystem services.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Biological Control and Biodiversity (Lecture, Exercise, Seminar) *Contents*: • Theoretical foundations of biological control • Natural enemy behaviour and biological control success • Biodiversity and ecosystem services in agroecosystems • Practical examples of biological control projects • Plant-herbivore-predator-interactionsPrinciples of population dynamics • Biological weed control	6 WLH
Examination: Written exam (70%; 45 minutes) and presentation (30%; approx. 20 minutes) **Examination prerequisites:** Regular attendance at seminar and exercise and presentation of a seminar talk **Examination requirements:** Basic knowledge of the mechanisms of biological control of herbivorous insects; methodological approaches based on case examples; role of biodiversity for ecosystem processes and the population dynamic of herbivorous insects, multitrophic interactions between plants, herbivorous insects and their natural enemies; biodiversity and services of ecosystems.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Michael Georg Rostás
Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 12	

Georg-August-Universität Göttingen **Modul M.Agr.0010: Biotechnological Applications in Plant Breeding** *English title: Biotechnological Applications in Plant Breeding*	6 C 4 SWS
Lernziele/Kompetenzen: Studierende erlernen Kenntnisse über biotechnologische Methoden selbständig auf aktuelle Probleme anzuwenden und Lösungswege zu entwickeln. Sie lernen komplexe wissenschaftliche Texte zu analysieren, aufzuarbeiten und in verständlicher Form an Dritte weiterzugeben	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Biotechnological Applications in Plant Breeding (Blockveranstaltung, Praktikum, Vorlesung, Seminar) *Inhalte*: Die Studenten erwerben in diesem Modul vertiefte theoretische und praktische Kenntnisse über biotechnologische und molekulargenetische Methoden in der Pflanzenzüchtung. Im Rahmen der studentischen Seminare werden dazu aktuelle Anwendungen in der Pflanzenzüchtung und der Landwirtschaft vorgestellt und deren Auswirkungen kritisch diskutiert. Zentrale theoretische und praktische Inhalte sind die Anwendung der schnellen In-vitro-Vermehrung, Erzeugung und Nutzung von Haploiden, interspezifische sexuelle und somatische Hybridisierung, direkter und indirekter Gentransfer, biochemische und molekulare Charakterisierung transgener Pflanzen, aktuelle Anwendungen in der Gentechnik und Risikobeurteilung, Eigenschaften und Anwendung verschiedener molekularer Markertypen in der Pflanzenzüchtung.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Vertiefte und komplexe theoretische Kenntnisse über die wichtigsten biotechnologischen Methoden und Anwendungen in der Pflanzenzüchtung	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Christian Möllers
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 12	

Georg-August-Universität Göttingen **Modul M.Agr.0012: Empirische Methoden: Marktforschung und Verbraucherverhalten** *English title: Empirical Methods: Market Research and Consumer Behavior*	6 C (Anteil SK: 6 C) 4 SWS

Lernziele/Kompetenzen: Die Studierenden sind in der Lage, nach Abschluss dieses Moduls eigenständig ein empirisches Projekt von der Zieldefinition über die Erarbeitung des theoriegestützten Untersuchungsmodells bis zur Datenanalyse und -präsentation durchzuführen. Dies befähigt sie nicht nur für die entsprechenden Berufsfelder im Agrarmarketing, sondern liefert auch wichtige Grundlagen für empirische M.Sc.-Arbeiten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Empirische Methoden: Marktforschung und Verbraucherverhalten (Seminar) *Inhalte*: Vertiefte Veranstaltung zu den wichtigsten Erhebungs- und Analysemethoden der empirischen Marktforschung und den theoretischen Grundlagen der Käuferanalyse. Im theoretischen Teil wird die Konsumforschung als interdisziplinäre Forschungsdisziplin vorgestellt (Ökonomie, Psychologie, Soziologie, experimentelle Forschung). Im Marktforschungsteil werden die zentralen quantitativen und qualitativen Erhebungsmethoden vorgestellt. Im Anschluss erfolgt eine rechnergestützte Einführung in die modernen Verfahren der uni-, bi- und multivariaten Datenanalyse. Abschließend wird die Anwendung und Präsentation von Marktforschungsergebnissen behandelt.	4 SWS
Prüfung: Hausarbeit (max. 40 Seiten, 50%) und Präsentation (ca. 20 Minuten, 50%) (90 Minuten) **Prüfungsvorleistungen:** Erstellung eines Berichts (max. 10 Seiten, unbenotet) **Prüfungsanforderungen:** Prüfungsanforderungen sind dezidierte Kenntnisse der Theorien des Käuferverhaltens (insb.ökonomische Ansätze, psychologische Theorien, soziologische Theorien), qualitative Methoden, univariate statistische Verfahren der empirischen Sozialforschung, bivariate Verfahren, ausgewählte multivariate Verfahren (Faktorenanalyse, Clusteranalyse, Regressionsanalyse) Zur Teilnahme an der Klausur berechtigt sind jene Studierenden, die im Zuge des Moduls an der Erstellung eines wissenschaftlichen Berichtes beteiligt waren. Der Bericht umfasst eine empirische Auswertung von modulspezifischen Daten und wird innerhalb des Seminars angeleitet.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Achim Spiller
Angebotshäufigkeit:	**Dauer:**

jedes Sommersemester	1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.Agr.0014: Ernährungsphysiologie
English title: Nutrition Physiology</td><td>6 C
4 SWS</td></tr>
</table>

<table>
<tr><td>Lernziele/Kompetenzen:
Studierende werden befähigt, Kenntnisse aus unterschiedlichen Betrachtungsebenen der bisherigen tierernährungswissenschaftlichen Ausbildung zu integrieren und ihre Urteilsfähigkeit gegenüber Fachfragen zu entwickeln. Zugleich werden aktuelle Forschungsansätze diskutiert und über eigenständige Referate die selbstständige Wissensaneignung und Kommunikationsfähigkeit auf wissenschaftlichem Niveau vermittelt.</td><td>Arbeitsaufwand:
Präsenzzeit:
56 Stunden
Selbststudium:
124 Stunden</td></tr>
</table>

<table>
<tr><td>Lehrveranstaltung: Ernährungsphysiologie (Vorlesung, Übung)
Inhalte:
Aufbauend auf den Modulen"Nutztierwissenschaften I" (2. Sem.) und Tierernährung (PM BSc., 6. Sem.) werden spezielle und vertiefende ernährungsphysiologische Kenntnisse über Nutztiere vermittelt. Zugleich werden Voraussetzungen für weitere Module des Fachgebietes geschaffen (z.B. Leistungsphysiologie, Untersuchungsmethoden, Futtermittel, Kompaktmodule "Milchrind", "Schwein", "Geflügel").

Es erfolgt eine vertiefte ernährungsphysiologische Bewertung der Nahrungsinhaltsstoffe (mit Übungen) und Zusatzstoffe sowie deren Umsetzungen für Erhaltungs- und Leistungsprozesse. Die Prozesse der Nahrungsaufnahme, Verdauung und Absorption sowie postabsorptiver Verwertungsgesetzmäßigkeiten unter Einbeziehung von Regulationsmechanismen und Quantifizierungsmöglichkeiten finden besondere Beachtung, ebenso wie speziesabhängige Verwertungsbesonderheiten. Bewertungssysteme für Futter und Bedarf werden in diese Zusammenhänge eingeordnet, ebenso ernährungsphysiologische Steuerungsmöglichkeiten für Prozesse der Nährstoffverwertung und deren ökologische Bezüge.</td><td>4 SWS</td></tr>
<tr><td>Prüfung: Mündlich (ca. 30 Minuten)
Prüfungsanforderungen:
Spezifische und umfassende Kenntnisse der Mechanismen der Verzehrsregulation und verdauungsphysiologischen Prozesse (einschl. deren Bewertung) bei Nutztieren, die Stoffwechselwege der Hauptnährstoffe und Beiträge zur Energie- und Nährstoffversorgung; weitreichende Kenntnisse der energetischen und stofflichen Bewertung von Futter und Bedarf als Grundlage für Versorgungsempfehlungen; Kenntnisse von Mineralstoff- und Vitaminumsatz in Beziehung zu Tierart, Leistung, Bioverfügbarkeit und Bedarf. Präzise Kenntnisse der Einflussfaktoren auf ernährungsphysiologische Prozesse (Antinutritiva, Zusatzstoffe, Futterbehandlungen).</td><td>6 C</td></tr>
</table>

<table>
<tr><td>Zugangsvoraussetzungen:
keine</td><td>Empfohlene Vorkenntnisse:
Kenntnisse aus den in den Modulen
"Nutztierwissenschaften I" und
"Tierernährung" behandelten Themenbereichen werden erwartet.</td></tr>
</table>

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Frank Liebert
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul M.Agr.0017: Genetische Grundlagen der Pflanzenzüchtung** *English title: Genetic Principles of Plant Breeding*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben die Fähigkeit, methodische Alternativen in der Pflanzenzüchtung in konkreten Situationen gegeneinander abzuwägen. Sie lernen, kürzlich erlerntes Wissen zu integrieren und mit komplexen Fragestellungen in der Pflanzenzüchtung umzugehen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Genetische Grundlagen der Pflanzenzüchtung (Vorlesung, Übung) *Inhalte*: Es werden die Grundkenntnisse einer effektiven und nachhaltigen Nutzung der genetischen Diversität in der Pflanzenzüchtung gelehrt. Zentrale Punkte sind: genetische und genotypische Strukturen pflanzlicher Populationen incl. Drift und Selektion, Management genetischer Ressourcen, Ursache und Nutzung von Heterosis, Quantitative Genetik, Erblichkeit, Ertragsstabilität, Zuchtmethoden mit Einsatz von DNS-Markern.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlagen zu: Zuchtmethoden, Konzept der Ertragsstabilität, DNS-Marker zur Analyse genetischer Diversität. Gute Kenntnis: Populationsgenetik, Quantitative Genetik, Management pflanzengenetischer Ressourcen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** apl. Prof. Dr. Wolfgang Link
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Bemerkungen:

Dieses Modul und das Modul "Plant Breeding Methodology and Genetic Resources" ergänzen sich wechselseitig.

Die Vorlesung findet in englischer Sprache statt, allerdings gibt es einen deutschen Teil, sowie eine deutsche Zusammenfassungen.

Georg-August-Universität Göttingen **Modul M.Agr.0018: Genomanalyse landwirtschaftlicher Nutztiere I** *English title: Genom Analysis of Livestock I*	6 C 6 SWS

Lernziele/Kompetenzen: Die Studierenden erwerben im Rahmen von Projektarbeiten die Fähigkeit molekularbiologische Techniken zur Genanalyse, Isolierung und Charakterisierung von Genen, funktionelle Genanalyse zielgerichtet einzusetzen. Sie sind mit molekularbiologischen Techniken vertraut und können diese selbständig in molekularbiologischen Arbeiten durchführen.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Genomanalyse landwirtschaftlicher Nutztiere I (Übung) *Inhalte*: Molekularbiologische Grundtechniken (DNA-Isolierung, RNA-Isolierung, Gelelektrophorese, Blotting, PCR, RFLP, Klonierung).	6 SWS
Prüfung: Hausarbeit (max. 30 Seiten) **Prüfungsanforderungen:** Grundlagenkenntnisse der genannten Lehrinhalte. Des Weiteren Anfertigung eines Protokolls, welches in der Struktur und im Inhalt einem wissenschaftlichen Manuskripts entsprechen soll. Das Protokoll soll enthalten 1. Zusammenfassung: Zusammenfassung des Projekts, Fragestellung und wesentliche Ergebnisse (max. 300 Worte) 2. Einleitung: Kurze Darstellung der Aufgabenstellung und Beschreibung des Stands der Wissenschaft (max. 1000 Worte) 3. Material und Methoden: Genaue Beschreibung der verwendeten Techniken und Materialen (max. 1500 Worte) 4. Ergebnisse: Beschreibung der Ergebnisse des Projekts mit Abbildungen und Tabellen (max. 2000 Worte) 5. Diskussion: Interpretation der Ergebnisse im Vergleich zum Stand der Wissenschaft (max. 2000 Worte) 6. Referenzen: Zusammenstellung der verwendeten Literatur mit entsprechender bibliographischer Software	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** M.Agr.0040
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Dr. Bertram Brenig
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 4	

Georg-August-Universität Göttingen **Modul M.Agr.0019: Genomanalyse landwirtschaftlicher Nutztiere II** *English title: Genome Analysis of Livestock II*	6 C 6 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben im Rahmen von Projektarbeiten die Fähigkeit molekularbiologische Spezialtechniken zur Genanalyse, Isolierung und Charakterisierung von Genen, funktionelle Genanalyse zielgerichtet einzusetzen. Sie kennen molekularbiologische Grundtechniken und können die Spezieltechniken selbständig in molekularbiologischen Arbeiten anwenden.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Genomanalyse landwirtschaftlicher Nutztiere II (Übung) *Inhalte*: Molekularbiologische Spezialtechniken (DNA-Sequenzierung, FRET, Transfektion, Zellkultur, foot printing, EMSA)	6 SWS
Prüfung: Hausarbeit (max. 30 Seiten) **Prüfungsanforderungen:** Vertiefte Kenntnisse molekularbiologischer Spezialtechniken. Des Weiteren Anfertigung eines Protokolls, welches in der Struktur und im Inhalt einem wissenschaftlichen Manuskripts entsprechen soll. Das Protokoll soll enthalten 1. Zusammenfassung: Zusammenfassung des Projekts, Fragestellung und wesentliche Ergebnisse (max. Worte) 2. Einleitung: Kurze Darstellung der Aufgabenstellung und Beschreibung des Stands der Wissenschaft (max. Worte) 3. Material und Methoden: Genaue Beschreibung der verwendeten Techniken und Materialen (max. 1500 Worte) 4. Ergebnisse: Beschreibung der Ergebnisse des Projekts mit Abbildungen und Tabellen (max. 2000 Worte) 5. Diskussion: Interpretation der Ergebnisse im Vergleich zum Stand der Wissenschaft (max. 2000 Worte) 6. Referenzen: Zusammenstellung der verwendeten Literatur mit entsprechender bibliographischer Software	6 C

Zugangsvoraussetzungen: M.Agr.0018	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Dr. Bertram Brenig
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 4	

Georg-August-Universität Göttingen **Modul M.Agr.0020: Genome analysis and application of markers in plantbreeding** *English title: Genome Analysis and Application of Markers in Plantbreeding*	6 C 4 SWS

Lernziele/Kompetenzen: Studierende erlernen ihre Kenntnisse in klassischer Genetik auf Problemlösungen in züchterischen Situationen anzuwenden. Studierende erlernen selbständig sich Kenntnisse im Umgang mit großen Datensätzen anzueignen und sich in entsprechende Software einzuarbeiten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Genome analysis and application of markers in plantbreeding (Vorlesung, Übung) *Inhalte*: Überblick über verschiedene Typen von molekularen Markern. Schätzung von genetischen Distanzen. Grundlagen der klassischen Genetik zur Kopplungsanalyse. Konstruktion von Kopplungskarten. Markergestützte Rückkreuzung. Kartierung von QTL: Theorie und praktische Übungen mit großen Datensätzen aus früheren Experimenten. Grundlagen der Bioinformatik: Vergleich von DNA Sequenzen.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Abgabe der Lösung von Übungsaufgaben **Prüfungsanforderungen:** Grundlagenkenntnisse in klassischen und molekularen Methoden der Kartierung von Genen. Basiskenntnisse im Einsatz molekularer Marker in der Pflanzenzüchtung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** apl. Prof. Dr. Wolfgang Link PD Dr. Wolfgang Ecke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0022: Honigbienen und Wildbienen in der Agrarlandschaft** *English title: Honey Bees and Wild Bees in the Agricultural Landscape*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden sollen die Biologie von Honigbienen und Wildbienen kennenleren, um die große Bedeutung dieser Bestäuber von Kultur- ind Wildpflanzen besser einschätzen und nutzen zu können. Die praktische Einführung in die Imkerei erlaubt einen ersten Einstieg in dieses traditionelle landwirtschaftliche Gebiet. Bienenartenkenntnisse und praktische Erfahrungen bei der Pollenanalyse und Anfertigung von Nisthilfen stellen wichtige methodische Grundlagen dar.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Honigbienen und Wildbienen in der Agrarlandschaft (Vorlesung, Übung) *Inhalte*: Einführung in die Lebensweise von Honigbienen und Wildbienen, Grundlagen und Techniken der Imkerei (Völkerführung, Trachtnutzung), Ressourcennutzung von Honigbienen und Wildbienen (Bienentänze, Blütenbesuch, Pollenanalyse), Taxonomie von Wildbienen, Krankheiten und Gegenspieler von Bienen, Wildbienen in unterschiedlichen Lebensräume.	4 SWS
Prüfung: Referat (ca. 20 Minuten, 50%) und Protokoll (max. 40 Seiten, 50%) **Prüfungsanforderungen:** Im Rahmen des Moduls Honigbienen und Wildbienen in der Agralandschaft werden Kentnisse der Biologie von Wild- und Honigbienen, Grundlagenwissen zur Imkerei und zur Bestäubung von Kultur- und Nutzpflanzen, methodische Grundkenntnisse zur Erfassung von Wild- und Honigbienen abgefragt. Referat: eigenständige Ausarbeitung zu einem Thema, 20 Minuten, Vortrag auf deutsch oder englisch; Protokoll: zusammenfassende Darstellung der einzelnen Kurstage, Umfang je nach Kurstag 1-5 Seiten, insgesamt 20-40 Seiten.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Westphal
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0023: Interactions between plants and pathogens** *English title: Interactions between Plants and Pathogens*	6 C 4 SWS

Lernziele/Kompetenzen: Kenntnisse komplexer Wechselwirkungen zwischen Pflanzen und Pathogenen. Ableitung wissenschaftlicher Fragestellungen und kritische Bewertung von angewendeten Methoden unterstützt durch eigene praktische Labortätigkeit.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Interaktionen zwischen Pflanzen und phytopathogenen Organismen sowie Viren (Praktikum, Vorlesung) *Inhalte*: Das Modul beschäftigt sich mit der Wechselwirkung von Pflanzen mit phytopathogenen Pilzen, Bakterien und Viren. Hierbei werden pilzliche, bakterielle und virale Aspekte der Infektionslehre behandelt. In diesem Rahmen wird die Sporenkeimung, das Eindringen und die Ausbreitung der Pathogene (incl. Virusreplikation und –verbreitung) in der Wirtspflanze dargestellt. An die Infektionslehre folgt die Beschreibung pflanzlicher Resistenzfaktoren (präformierte und induzierte), deren Bedeutung sowie pathogenseitige Möglichkeiten der Inaktivierung. Als weitere Inhalte des Moduls werden Phänome, wie die induzierte und/oder systemisch erworbene Resistenz (SAR) beschrieben. Detailiert wird auf das Pathosystem Agrobacterium tumefaciens / dikotyle Pflanzen eingegangen. An konkreten Beispielen wird die Gen-für-Gen Hypothese und ihr experimenteller Nachweis erläutert. Hierbei wird kurz und beispielhaft auf bekannte Resistenzgene eingegangen. Im Rahmen des praktischen Teils werden von den Studierenden Phytoalexinextraktionen aus Raps vorgenommen sowie analytische Verfahren zu deren Nachweis und biologischen Wirksamkeit mittels chromatografischer Techniken (HPLC bzw. TLC-Bioassay) durchgeführt.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Teilnahme am praktischen Teil des Moduls im Anschluss an die Vorlesung und Anfertigung eines von den Prüfenden inhaltlich akzeptierten Protokoll **Prüfungsanforderungen:** Profunde Kenntnisse von Infektionsvorgängen bei Viren, Bakterien und Pilzen, von Mechanismen der Wirtserschließung, Pathogenerkennung, Signaltransduktion, präformierter und induzierter Resistenzmechanismen sowie der Gen-für-Gen Hypothese	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Birger Koopmann
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 36	

Georg-August-Universität Göttingen **Modul M.Agr.0025: Kartoffelproduktion** *English title: Potato Production*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erlernen, die in einer multidiziplinär ausgerichteten Lehrveranstaltung vermittelten Kenntnisse in ein bereits vorhandenes Wissensgerüst zu integrieren, zu vergleichen und zu bewerten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Kartoffelproduktion (Vorlesung, Übung) *Inhalte*: Herkunft, Biologie, ernährungsphysiologische Bedeutung der Kartoffel Wirtschaftliche Bedeutung des Kartoffelanbaues Züchtung und Sorten, Anbau und Düngung, Krankheiten im Kartoffelbau und Möglichkeiten ihrer Bekämpfung, Technik im Kartoffelbau (Anbau, Ernte, Lager), Qualität von Kartoffeln und Verarbeitungsprodukten, Anforderungen an eine qualitätserhaltende Lagerung, Verarbeitung von Kartoffeln; Marketing; Übungen, Exkursion	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Weiterführende Kenntnisse • zur ernährungsphysiologischen Bedeutung der Kartoffel sowie zur wirtschaftlichen Bedeutung des Kartoffelanbaus • zur Qualitätsbeeinflussung der Kartoffeln durch Anbau und Düngung, Einsatz von PSM, Lagerung • zu Züchtungszielen, -möglichkeiten und Sortenschutz • zu Krankheiten im Kartoffelanbau und deren Bekämpfung • zur Verarbeitung der Kartoffel zu frittierten und getrockneten Produkten	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Marcel Naumann
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul M.Agr.0027: Kompaktmodul - Das Geflügel** *English title: Compact Course - Poultry*	6 C 6 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Die Studierenden erwerben in dem Modul wissenschaftliche Grundlagen der Geflügelhaltung. Sie verstehen die komplexen Zusammenhänge zwischen Tieransprüchen, Haltungsformen, Tiergesundheit und Wirtschaftlichkeit. Auf Grundlage der erworbenen Kenntnisse können sie die verschiedenen Formen der Geflügelhaltung analysieren und bewerten. Sie können sich in neue Konzepte der Geflügelhaltung selbständig einarbeiten. Sie erlenen, auf dem aktuellen Stand der Forschung ihr Wissen Fachvertretern und Praktikern zu vermitteln.	Präsenzzeit: 80 Stunden Selbststudium: 100 Stunden

Lehrveranstaltung: Kompaktmodul - Das Geflügel (Vorlesung, Exkursion)	6 SWS
Inhalte: • Organisation der Geflügelwirtschaft • Biologie des Geflügels und Zucht • Fütterung und Haltungsverfahren • Produkte vom Geflügel • Wirtschaftlichkeit der Geflügelhaltung • Reproduktion und Gesunderhaltung • Tiergerechte Haltungssysteme • Umweltauswirkungen der Geflügelhaltung • Spezialgeflügel (Puten, Enten, Gänse, Wildgeflügel) • Exkursionen *Angebotshäufigkeit:* Sommersemster 2015, dann alle zwei jahre	
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Teilnahme an den Exkursionen **Prüfungsanforderungen:** Wissenschaftliche Grundlagen der Organisation und Wirtschaftlichkeit, Biologie und Zucht, Fütterung, von Produkten, Reproduktion, Tiergesundheit, tiergerechter Haltungssysteme, Umweltauswirkungen und Spezialgeflügel	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jens Tetens
Angebotshäufigkeit: Sommersemster 2015, dann alle zwei jahre	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 48	

Georg-August-Universität Göttingen **Modul M.Agr.0028: Kompaktmodul - Das Milchrind** *English title: Compact Course - Dairy cow*	6 C
Lernziele/Kompetenzen: Die Studierenden erwerben vertiefte Kenntnisse zu ausgewählten aktuellen Fragestellungen der Milchrinderzucht. Durch die themenzentrierte, interdisziplinäre Herangehensweise werden die ausgewählten Fragestellungen von vielen Seiten (Haltung, Züchtung, Hygiene, Ernährung, Ökonomie etc.) beleuchtet, so dass die Studierenden eine ganzheitliche Problemlösungskompetenz erwerben.	**Arbeitsaufwand:** Präsenzzeit: 73 Stunden Selbststudium: 107 Stunden
Lehrveranstaltung: Kompaktmodul - Das Milchrind (Blockveranstaltung, Vorlesung, Exkursion) *Inhalte*: Im Mittelpunkt dieses Moduls stehen aktuelle Themen rund um das Milchrind. Ausgewählte Fragestellungen der Zucht, Haltung, Ernährung, Produktkunde und Ökonomie des Milchrindes werden von Dozenten der Fakultät präsentiert. Einige Themen werden von externen Fachleuten erläutert. Während der zweitägigen Exkursion werden die theoretisch besprochenen Konzepte anhand praktischer Beispiele illustriert und vertieft. Durch die kompakte Blockstruktur eignet sich dieses Modul besonders auch für externe Hörer und Hörerinnen.	
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Vertiefte Kenntnisse in Zucht, Haltung, Ernährung, Produktkunde und Ökonomie des Milchrindes	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Ahmad-Reza Sharifi
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul M.Agr.0029: Kompaktmodul - Das Schwein** *English title: Compact Course - Pig*	6 C 6 SWS
Lernziele/Kompetenzen: Studierende erlernen ihr Wissen und Verstehen sowie ihre Fähigkeiten zur Problemlösung in neuen und unvertrauten Situationen anzuwenden. Die Kompetenz im Bereich Schwein wird hierbei in einem multidisziplinären Zusammenhang gestellt. Die Studierenden erlernen hier Wissen zu integrieren und mit der Komplexität der Fragestellungen umzugehen.	**Arbeitsaufwand:** Präsenzzeit: 140 Stunden Selbststudium: 40 Stunden
Lehrveranstaltung: Kompaktmodul - Das Schwein (Vorlesung, Exkursion) *Inhalte*: Im Rahmen dieses Moduls werden alle relevanten Teilbereiche und Stoffgebiete um das Nutztier Schwein dargestellt. Dies umfasst neben Zucht und Genetik, Haltung und Verfahrenstechnik, Strukturen in der Primärstufe sowie in den vor- und nachgelagerten Bereichen, Futterqualitätmanagement, Tiergesundheit, Integrationskonzepte, Produkt- und Prozessqualität, Zuchtstrategien, Tierschutz, Immissionsschutz usw. *Angebotshäufigkeit:* Alle zwei jahre im SoSe ab 2012	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse im Lehrbereich (Zucht und Genetik, Haltung und Verfahrenstechnik, Strukturen in der Primärstufe sowie in den vor- und nachgelagerten Bereichen, Futterqualitätmanagement, Tiergesundheit, Integrationskonzepte, Produkt- und Prozessqualität, Zuchtstrategien, Tierschutz, Immissionsschutz usw.). Als Stoffgebiet gelten sämtliche Lehrinhalte, die im Rahmen der Vorlesungen, der Exkursionen und Workshops vermittelt werden.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse aus den in den Modulen "Grundlagen der Agrartechnik" und "Grundlagen der Nutztierwissenschaften II" behandelten Themenbereichen werden erwartet.
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Imke Traulsen
Angebotshäufigkeit: Alle zwei jahre im SoSe ab 2012	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 44	

Bemerkungen: Die Exkursion ist für alle Studierende verpflichtend.

Georg-August-Universität Göttingen **Modul M.Agr.0031: Leistungsphysiologie** *English title: Performance Physiology*	6 C 4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Es wird insbesondere Wissen in einem vertieften physiologischen und z.T. multidisziplinären Zusammenhang vermittelt. Damit wird der Umgang mit komplexeren Kenntnissen bei der Problembewertung und -lösung in den Mittelpunkt gestellt. Problemorientierte Referate unterstützen die selbständige Aneignung von Wissen sowie die Verbesserung der kommunikativen Kompetenzen.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Leistungsphysiologie (Vorlesung) *Inhalte*: Kenntnisse der physiologischen Grundlagen des Stoffwechsels landwirtschaftlicher Nutztiere für Leistungsbereitschafts- und Leistungsprozesse in Wechselwirkung mit Umweltfaktoren; im Mittelpunkt stehen Leistungen im Erhaltungsumsatz sowie bei der Produktsynthese unter besonderer Beachtung der metabolischen Aufwendungen, Verwertungsgesetze und Bedarfsableitungen; Ergänzend werden physiologische Grundlagen wichtiger Organsysteme im Rahmen der Leistungsprozesse von Wachstum, Laktation, Muskelarbeit und Reproduktion behandelt; Regulation und Beeinflussung produktbildender und reproduktiver Prozesse (quantitativ/qualitativ); physiologische Leistungen bei aquatischen Organismen.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Vertiefte Kenntnisse der folgenden Inhaltsbereiche: Physiologische Prozesse bei Leistungsbereitschaft und resultierende Bedarfswerte (energetisch, stofflich); Mikrobielle Umsetzungen im Verdauungstrakt und Leistungsprozesse; Leberstoffwechsel sowie Wasser- und Elektrolythaushalt in Beziehung zu Leistungsprozessen; Prä- und postnatales Wachstum, Milchbildung, Spermiogenese, Eisynthese und Muskelarbeit - physiologische Prozesse und Bedarfsbewertung; Spezifik von Stoffwechsel- und Wachstumsprozessen bei aquatischen Organismen; Futterzusatzstoffe und Leistungsphysiologie; Beeinflussung von Leistungsprozessen (quantitativ, qualitativ) und deren Umweltwirkungen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse aus dem Themenbereich des BSc Nutztierwissenschaften, sowie den im Modul „Ernährungsphysiologie" behandelten Themen werden erwartet.
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Frank Liebert
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0033: Marketing Management in der Ernährungswirtschaft** *English title: Marketing Management in Agribusiness*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erhalten zunächst vertiefte Kenntnisse über die Strukturen auf den verschiedenen Stufen der Wertschöpfungskette. Auf dieser Basis werden Analyse- und Planungstechniken des Marketings vorgestellt und in Fallstudien und Projekten vertieft. Wichtige berufsfeldbezogene Kompetenzen sind: Zielgruppenanalyse, quantitative Planungstechniken, Controlling, Verhandlungsführung, Marketing-Organisation.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Marketing Management in der Ernährungswirtschaft (Seminar) *Inhalte*: Vertiefte Analyse der komplexen Wertschöpfungskette der Ernährungswirtschaft aus Marketingsicht. Behandelt werden die Grundlagen des Strategischen Marketings im Hinblick auf Business-to-Business (B2B) und Business to Consumer (B2C) Marketing. Das B2B-Marketing richtet sich auf die Zielgruppe institutioneller Kunden (insbesondere: Landwirtschaft, Lebensmittelhandel). Wichtige Themengebiete sind u. a. landwirtschaftliches Einkaufsverhalten und handelsgerichtetes Marketing. Im B2C-Marketing werden die Inhalte einer Grundlagenveranstaltung Marketing weiter vertieft, speziell mit Blick auf strategisches Marketing.	4 SWS
Prüfung: Klausur (60 Minuten, Gewichtung: 50%) und Hausarbeit (max. 15 Seiten, Gewichtung: 50%) **Prüfungsanforderungen:** Vertiefte Kenntnisse über die Strukturen auf den verschiedenen Stufen der Wertschöpfungskette. Das Modul ist in wesentlichen Teilen als Seminar und Fallstudienveranstaltung angelegt. In diesem Sinne werden in der Veranstaltung Schwerpunkte auf aktuelle Fragestellungen des Marketing Managements in der Ernährungswirtschaft gelegt. Diese werden in Form von Fallstudienanalysen, kleineren empirischen Projekten, Rollenspielen u. ä. Formen der interaktiven Hoschuldidaktik vertieft. Die Prüfungsanforderungen ergeben sich daher aus den o. g. Kompetenzen vor dem Hintergrund des jeweilligen Vertiefungsgebietes.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Achim Spiller
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 180	

Georg-August-Universität Göttingen **Modul M.Agr.0034: Methodisches Arbeiten: Interdisziplinäre Projektarbeit** *English title: Methodological Work: Interdisciplinary Research Project*	6 C (Anteil SK: 6 C) 4 SWS
Lernziele/Kompetenzen: Die Studierenden sollen lernen, wie man die agrarwissenschaftlichen Inhalte, die im bisherigen Studium in diversen Modulen erarbeitet wurden, integrativ auf ein aktuelles Forschungsfeld anwendet. Damit ist verbunden, dass die Studierenden sich interdisziplinär breit bilden und die integrative Zusammenführung von Ergebnissen aus verschiedenen Themenbereichen erlernen. Die Erarbeitung von Teilproblemen ist auch mit dem Erlernen von Methoden (Versuchsanlage und -auswertung inkl. Statistik und oft auch GIS) verknüpft.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Methodisches Arbeiten: Interdisziplinäre Projektarbeit (Praktikum, Seminar) *Inhalte*: In diesem inhaltlich breit angelegten Pflichtmodul, das von DozentInnen aus der Ökonomie, den Nutzpflanzenwissenschaften und Nutztierwissenschaften gestaltet wird, erfolgt eine interdisziplinäre Erarbeitung eines aktuellen Themas aus dem Bereich des Ressourcenmanagements. Die Arbeitsthemen umfassen Vergleiche zwischen verschiedenen Formen praktischer Landwirtschaft (z.B. organischer vs. integrierter vs. konventioneller Landwirtschaft), Klimawandel und Agrarökosysteme, Bioenergie oder auch Extensivierung der Produktion und Zertifizierung der Produkte. Das Thema wird in mehreren Arbeitsgruppen erarbeitet, die ihre Planungen und Ergebnisse vorstellen und diskutieren und letztlich zu einer Gesamt-Beurteilung zusammenführen.	
Prüfung: Hausarbeit (max. 20 Seiten, Gewichtung: 70%) und Präsentation, Referat oder Korreferat (ca. 12 Minuten, Gewichtung 30%) **Prüfungsanforderungen:** Im Rahmen des Moduls Methodisches Arbeiten: Interdiziplinäre Projektarbeit werden Kenntnisse zur Verknüpfung von bereits erlernten agrarwissenschaftlicher Inhalten zur Anwendung auf ein aktuelles Thema im Bereich Ressourcenmanagement vermittelt. Die Erarbeitung von Teilproblemen ist auch mit dem Erlernen von Methoden (Versuchsanlage und -auswertung inkl. Statistik und oft auch GIS) verknüpft. Referat: In einem 12-minutigen Referat werden die Ergebnisse der Felduntersuchungen präsentiert und kritisch diskutiert. Dies beinhaltet neben einer kurzen Einleitung die Darstellung der Untersuchungshypothesen, Feld-/Labormethoden, statistische Datenauswertung und eine Diskussion der Ergebnisse unter Einbeziehung von Sekundärliteratur, wie z.B. wissenschaftlichen Fachpublikationen (30% der Modulnote). Hausarbeit: In einer schriftlichen Hausarbeit (Umfang max. 20 Seiten) werden die Versuche im Stil einer wissenschaftlichen Veröffentlichung dargelegt. Die Hausarbeit wird hierbei gegliedert in: Zusammenfassung, Einleitung, Hypothesen, Methoden, Resultate, Diskussion und Quellen. Neben formalen Aspekten (z.B. Darstellung der Ergebnisse, Orthografie, korrekte Zitierweise) steht insbesondere die Diskussion der	6 C

eigenen Ergebnisse unter Berücksichtigung der wissenschaftlichen Fachliteratur im Fokus der Prüfungsanforderungen (70% der Modulnote)	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Westphal
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0035: Methodisches Arbeiten: Interdisziplinäres Seminar** *English title: Methods of Scientific Presentation: An Interdisciplinary Course*	6 C (Anteil SK: 6 C) 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben vertiefte Kompetenz in der Erschließung und Diskussion eines wissenschaftlichen Themas sowie der mündlichen und schriftlichen Präsentation des Stoffes. Diese Arbeiten erfolgen in enger Zusammenarbeit mit der Betreuerin/dem Betreuer des Themas. Sowohl die Literatursuche, die mündliche als auch die schriftliche Leistung werden mit den Studierenden erörtert, so dass sie ihre eigene Leistung einschätzen können. Die Studierenden können so ihre Stärken und Schwächen einordnen und bei zukünftigen Anlässen weitere Verbesserungen vornehmen. Die erworbenen Kompetenzen beziehen sich in gleicher Weise auf die wissenschaftliche Korrektheit als auch auf die didaktische und strukturelle Konsistenz. Dies gilt für Vortrag und Hausarbeit.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden
Lehrveranstaltung: Methodisches Arbeiten: Interdisziplinäres Seminar (Seminar) *Inhalte*: Im einleitenden Vorlesungsteil werden den Studierenden die Methoden vermittelt, wissenschaftliche Texte zu einem Thema aufzuarbeiten und die Inhalte zu einem Vortrag und zu einer schriftlichen Arbeit zu verdichten. Danach werden Themen aus dem Bereich der Pflanzenproduktion von den Studierenden vorgetragen und zusammen mit Dozenten des Departments für Nutzpflanzenwissenschaften diskutiert. Die Studierenden sollen lernen, die Literatur zu einem fachspezifischen Thema zu erschließen und die Ergebnisse zu präsentieren. Die Vortragenden erarbeiten eine Kurzfassung, die allen Seminarteilnehmern zur Verfügung steht, und eine ausführliche 15 bis 20-seitige Langfassung (Seminararbeit). Die Art und Weise des Vortrages und die Fertigung der Seminararbeit werden eingehend geschult.	4 SWS
Prüfung: Hausarbeit (Gewichtung: 50%, Umfang: max. 15 Seiten) und Präsentation, Referat oder Korreferat (Gewichtung: 50%, Dauer: ca. 20 Minuten) **Prüfungsvorleistungen:** Erfolgreiche Präsentation und Diskussion der Seminaraufgabe, erfolgreiche schriftliche Ausarbeitung der Seminaraufgabe **Prüfungsanforderungen:** Vertiefte Kenntnisse in ausgewählten Gebieten der Nutzpflanzenwissenschaften, Rhetorik, Literatursuche und -verarbeitung, Anfertigen der Hausarbeit, Präsentation	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Frank Beneke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 80	

Georg-August-Universität Göttingen **Modul M.Agr.0036: Methodisches Arbeiten: Versuchsplanung und -auswertung** *English title: Methods of Scientific Presentation: Experiment Planning and Evaluation*	6 C (Anteil SK: 6 C) 4 SWS
Lernziele/Kompetenzen: Studierende erlernen Grundlagen der statischen Versuchsauswertung auf praktische Beispiele anzuwenden und fundierte Entscheidungen zur Aussagekraft der Versuche zu fällen. Die Beispiele aus den Bereichen Pflanzenproduktion, Tierproduktion und Ökologie fördern eine multidisziplinäre Betrachtungsweise. Sie erlernen in einem Team die verantwortliche Planung von Versuchen unter Berücksichtigung praktischer Restriktionen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Methodisches Arbeiten: Versuchsplanung und -auswertung (Vorlesung, Übung) *Inhalte*: Das Modul soll grundlegende Kenntnisse der Versuchsplanung und -auswertung, die für die Anwendung im Agrarbereich relevant sind, vermitteln. Die Planung und Auswertung z. B. von Feldversuchen, von Fütterungs- und Züchtungsversuchen, von Vergleichen verschiedener Haltungsverfahren, von Umfragen und Erhebungen werden praxisnah dargestellt. Die Vorlesung ist Grundlage für andere Vorlesungen, z.B. im Züchtungsbereich. In einem ersten Teil der Vorlesungen und Übungen werden die Grundlagen zum Schätzen und Vergleichen von typischen Parametern wie Mittelwerten und Varianzen dargestellt. Es werden einfache und faktorielle Versuchsanlagen und deren Auswertung im Rahmen von Varianzanalysen besprochen. Konzepte der Versuchsplanung wie Randomisieren und Art und Umfang der Versuchsanlagen werden besprochen. In Arbeitsgruppen sollen dann typische Versuche aus dem Bereich der Tier- und Pflanzenproduktion und dem Umweltbereich beispielhaft geplant werden. In dem zweiten Teil der Vorlesung werden lineare und nicht-lineare Beziehungen zwischen Variablen einschließlich multivariater Methoden vorgestellt. Die Analyse von Häufigkeitsdaten und die Anwendung von allgemeinen linearen Modellen ergänzen die Vorlesung. In einem weiteren praktischen Teil wird die Auswertung von beispielhaften Versuchen in Arbeitsgruppen geübt. Abgeschlossen wird die Vorlesung mit der Diskussion häufig auftretender Probleme in der Versuchsplanung und -auswertung.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundkenntnisse der • Methoden zur Planung von Versuchen • Statischen Methoden zur Auswertung von Versuchen	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache:	**Modulverantwortliche[r]:**

Deutsch	Prof. Dr. Ahmad-Reza Sharifi
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 80	

Bemerkungen: Dieses Modul und M.Cp.0016 "Practical statistics and experimental design in agriculture" schließen sich gegenseitig aus.

Georg-August-Universität Göttingen **Modul M.Agr.0039: Molecular Techniques in Phytopathology** *English title: Molecular Techniques in Phytopathology*	6 C 4 SWS

Lernziele/Kompetenzen: Methodische Kenntnisse im Umgang mit Nukleinsäuren, Ableitung von methodischen Lösungsansätzen für eigene wissenschaftliche Fragestellungen. Präsentation von Ergebnissen und grundlegenden Methodenkenntnissen sowie Ergebnisinterpretation im Rahmen einer Abschlussbesprechung.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Molecular Techniques in Phytopathology (Praktikum, Vorlesung) *Inhalte*: Im Rahmen dieses Praktikums werden mit Hilfe von Experimenten grundlegende molekularbiologische Techniken vermittelt: Isolierung von Plasmiden und Gesamt-DNA sowie DNA-Fragmenten aus Agarosegelen, Restriktionsanalyse, Agarose-Gelektrophorese, Klonierung von PCR-Produkten (enzymatische Modifikation, Ligation),Transformation und in vivo Amplifikation von Plasmiden, DNA Blotting, Markierung von DNA-Sonden mit nicht-radioaktiven Methoden (DIG-dUTP), Southern-Hybridisierung und immunologische Detektion von hybridisierten Sonden mit Chemolumineszenzsubstraten, ITS-RFLP-Analysen bei pilzlichen Rapspathogenen, Real-time PCR-Diagnostik von mykotoxinbildenden pilzlichen Getreidepathogenen. In dem begleitenden Vorlesungsteil werden grundlegende und anwendungs-bezogene nukleinsäurechemische und proteinchemische Kenntnisse vermittelt, die zum Verständnis nicht nur der vorgestellten Techniken notwendig sind. Zudem werden in einem anwendungsbezogenen Teil Lösungsansätze für bestimmte wissenschaftliche Fragestellungen dargelegt und diskutiert.	4 SWS
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsvorleistungen:** Anfertigung eines für den Prüfenden akzeptierten Praktikumsprotokolles **Prüfungsanforderungen:** Grundlegende Kenntnisse über den Aufbau von Nukleinsäuren, von Enzymen und deren Einsatz in molekular-biologischen Experimenten, von Standardanalyseverfahren (Southern Blot, PCR, Elektrophorese, DNA-Sequenzierung), der Analyse multivariater Daten sowie dem Einsatz verschiedener Verfahren für wissenschaftliche Fragestellungen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Birger Koopmann
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 16	

Georg-August-Universität Göttingen **Modul M.Agr.0040: Molekularbiologie und Biotechnologie in den Nutztierwissenschaften** *English title: Molecular Biology and Biotechnology in Animal Science*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben vertiefende Kenntnisse im Bereich des Aufbaus eukaryontischer Genome, der Struktur und Funktion von Genen, Regulation der Genexpression, in der vergleichenden Genomanalyse, Verfahren zur Analyse molekularbiologischer Fragestellungen. Sie kennen außerdem molekularbiologische Standardtechniken (DNA-Isolierung, DNA-Sequenzierung, Klonierung, Elektrophorese), mikrobiologische Techniken in der Molekularbiologie (Vermehrung und Handhabung von E. coli und S. cereviseae, Transformation), molekularbiologische Diagnostik (Abstammungskontrolle, Lebensmitteluntersuchungen, Erregernachweis) und können diese anwenden.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Molekularbiologie und Biotechnologie in den Nutztierwissenschaften (Vorlesung, Übung) *Inhalte*: Molekularbiologie und Molekulargenetik der Haustiere, Genomstruktur, Genaufbau, Chromosomenaufbau, Genexpression, molekulkarbiologische Techniken, Forensik, Abstammungsdiagnostik, Gendiagnostik.	4 SWS
Prüfung: Klausur (90 Minuten, Gewichtung: 50%) und Hausarbeit (max. 20 Seiten, Gewichtung: 50%) **Prüfungsanforderungen:** Vertiefte Kenntnisse der Mendelschen Genetik, molekularer Genetik, von Genomstruktur, Genaufbau, Genexpression, molekularbiologischen Techniken und vergleichenden Genanalyse.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Dr. Bertram Brenig
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul M.Agr.0045: Mycology** *English title: Mycology*	6 C 4 SWS

Lernziele/Kompetenzen: Umgang mit und Erkennung von phytopathogenen Pilzen. Experimentelles Arbeiten im Rahmen verschiedener phytopathologischer Fragestellungen. Gruppenarbeiten mit Übernahme von Sprecherfunktion, Auswertung und Darstellung von Versuchsergebnissen in einer englischsprachigen Präsentation	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Mycology (Praktikum, Vorlesung) *Inhalte*: Überblick über die Ökologie und Taxonomie phytopathologisch relevanter Pilze. Übungen zur taxonomischen Klassifizierung anhand morphologischer Merkmale an Reinkulturen, Durchführung von Versuchen zur Pilzisolierung, Antagonistengewinnung, Nachweis natürlicher Fungistatis im Boden, Saatgutdesinfektion, in situ Studien zur Pathogenese von biotrophen und nekrotrophen Pilzen, Rassenbestimmungen beim Echten Mehltau, Untersuchungen zur Fungizidresistenz.	4 SWS
Prüfung: Mündlich (ca. 20 Minuten) **Prüfungsvorleistungen:** Gruppenprotokoll und Ergebnispräsentation **Prüfungsanforderungen:** Grundlagenkenntnisse in Pilztaxonomie, Lebenszyklen, ökologischer Ansprüche, diagnostischer Merkmale, Krankheiten und pflanzenassozierte Strukturen, Abwehrmechanismen und Methoden	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Andreas von Tiedemann
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 1
Maximale Studierendenzahl: 12	

Georg-August-Universität Göttingen **Modul M.Agr.0048: Naturschutz interfakultativ II** *English title: Nature Conservation II (interfaculty lectures)*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden sollen sich durch die interfakultative Naturschutzausbildung ein breites Wissen im Bereich Naturschutz aneignen und die Beiträge aus Agrarwissenschaften, Biologie, Forstwissenschaften und Geographie zu einem Gesamtbild zusammenführen. Dazu gehören die inhaltliche Integration unterschiedlicher Methoden und Ansätze und die kritische Bewertung des Beitrags verschiedener Disziplinen zu aktuellen Problemen des Globalen Wandels.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Naturschutz interfakultativ 2 (Praktikum, Seminar) *Inhalte*: Im Rahmen einer einheitlichen interfakultativen Naturschutzausbildung für die vier "grünen" Fakultäten (Agrar, Bio, Forst, Geo) werden insgesamt zwei Module (Naturschutz interfakultativ I und II) angeboten, die für ein entsprechendes Zertifikat (des Zentrums für Naturschutz) für Studierende aus allen vier Fakultäten gleichermaßen verbindlich sind. In diesem zweiten Block geht es um die : Landschaftsplanung, Schwerpunkte Forstbetrieb und Waldnutzung sowie Naturschutz und Waldökologie und Naturschutzpolitik, Schwerpunkt: Naturschutz und Waldökologie (alle aufgeführten Veranstaltungen durch das Institut für Forstpolitik, Forstgeschichte und Naturschutz).	
Prüfung: Klausur (60 Minuten) **Prüfungsanforderungen:** Erarbeitung des in den Vorlesungen angebotenen Wissens.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Westphal
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul M.Agr.0052: Ökologie und Naturschutz** *English title: Ecology and Nature Conservation*	6 C 6 SWS

Lernziele/Kompetenzen: Die Studierenden sollen die Lebensraumtypen und Lebensgemeinschaften der Agrarlandschaften so kennenlernen, dass sie Bewertungen unter Naturschutzgesichtspunkten vornehmen können. Dazu gehört ein tiefes und interdisziplinäres Verständnis von Biodiversitätsmustern und ökologischen Prozessen, wie sie nur durch eine Integration von Ökologie, Umweltökonomie, Nutzpflanzen- und Nutztierwissenschaften erfolgen kann. Zudem werden statistische Fertigkeiten erworben, die für den Test komplexer Fragestellungen wichtig sind.	**Arbeitsaufwand:** Präsenzzeit: 79 Stunden Selbststudium: 101 Stunden

Lehrveranstaltung: Bewertung und Pflege von Lebensräumen (Übung, Seminar) *Inhalte*: Charakterisierung der Lebensräume der Agrarlandschaft, biologische Schädlingsbekämpfung und Räuber-Beute-Beziehungen, Biotopvernetzung und genetische Differenzierung isolierter Populationen, Versuchsplanung bei ökologischen Fragestellungen, Landschaftsplanung und Biotopbewertung, interdisziplinäre Perspektive auf Fragen der umweltfreundlichen Agrarproduktion, naturschutzgerechten Landschaftsplanung und Ressourcenmanagements.	4 SWS
Prüfung: Präsentation, Referat oder Korreferat (Gewicht: 60%, Dauer: ca. 20 Minuten) und Hausarbeit (Gewicht: 40%, Umfang: max. 25 Seiten) **Prüfungsvorleistungen:** Teilnahme an den praktischen Übungen, Anwesenheitspflicht, max. 2 Fehltermine **Prüfungsanforderungen:** Interdisziplinäre Sichtweise auf Probleme im Spannungsfeld von Landwirtschaft und Naturschutz	3 C

Lehrveranstaltung: Landwirtschaft und Naturschutz (Seminar) *Inhalte*: Interdisziplinäre Perspektive auf Fragen der umweltfreundlichen Agrarproduktion, naturschutzgerechten Landschaftsplanung und des Ressourcenmanagements in multifunktionalen Agrarlandschaften.	2 SWS
Prüfung: Präsentation (ca. 20 Minuten) **Prüfungsvorleistungen:** Teilnahme an den praktischen Übungen, Anwesenheitspflicht, max. 2 Fehltermine **Prüfungsanforderungen:** Grundlegende Kenntnisse im Bereich der Bewertung und Pflege von Lebensräumen.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Westphal

Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Agr.0053: Organisation von Wertschöpfungsketten** *English title: Organization of Food Supply Chains*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen verschiedene Problemstellungen in Bezug auf die Organisation von Lebensmittelwertschöpfungsketten und Unternehmen des Agribusiness kennen. Sie können nachvollziehen, wie landwirtschaftliche Betriebe und Unternehmen ihre Beziehungen, Strukturen und Prozesse an technische und soziale Einflüsse ihrer internen und externen Umwelt anpassen. Das Verstehen organisationswissenschaftlicher Theorien und Methoden befähigt die Studierenden, komplexe Problemstellungen zu erkennen und zu bewerten sowie Lösungen zu entwickeln. Die Studierenden sind außerdem in der Lage, sich weiterführendes Wissen und Können anzueignen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Organisation von Wertschöpfungsketten (Vorlesung, Seminar) *Inhalte*: Das Modul führt in Grundzüge der organisatorischen Gestaltung von Wertschöpfungsketten der Agrar- und Ernährungswirtschaft ein. Gestützt auf ausgewählte Organisationstheorien werden verschiedene für die Agrar- und Ernährungswirtschaft bedeutsame Organisationsprobleme thematisiert. Schwerpunkte der Lehrveranstaltung sind: • Effiziente Organisation von Lebensmittelwertschöpfungsketten: Verträge, Spot-Märkte, vertikale Integration • Wettbewerbsstrategie und effiziente Organisation von Lebensmittelwertschöpfungsketten • Stakeholder-Management für landwirtschaftliche Betriebe (z.B. beim Bau von Biogasanlagen) und Unternehmen des Agribusiness • Zertifizierungssysteme aus organisationstheoretischer Sicht • Genossenschaften als Organisationsalternative in der Agrar- und Ernährungswirtschaft • Transparenz von Lebensmittelwertschöpfungsketten Die Vorlesung bedient sich unterschiedlicher Organisationstheorien und stellt umfassend Bezüge zu praktischen Problemstellungen her.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Kenntnisse über ausgewählte Organisationstheorien und –methoden; Fähigkeit das Wissen auf praktische Problemstellungen des Agribusiness anzuwenden.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Silke Hüttel
Angebotshäufigkeit:	**Dauer:**

jedes Sommersemester	1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 100	

Bemerkungen: **Sprache**: Deutsch (für internationale Studenten: M.SIA.E18). Die Belegung des Moduls M.Agr.0053 schließt die Belegung des Moduls M.SIA.E18 aus.

Georg-August-Universität Göttingen **Modul M.Agr.0056: Plant breeding methodology and genetic resources** *English title: Plant Breeding Methodology and Genetic Resources*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden lernen, klassische und molekulare Methoden und Techniken bei der Lösung pflanzenzüchterischer Problemen zu integrieren. Sie lernen, eigene Schlussfolgerungen aus klassischen und neuesten Veröffentlichungen zu ziehen und diese Wissenschaftlern und Studierenden verständlich, knapp und klar zu vermitteln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Plant breeding methodology and genetic resources (Vorlesung) *Inhalte*: Grundlagen der Zuchtmethodik: Populationsgenetik, Zuchtmethoden in der Klon-, Linien-, Hybrid- und Populationszüchtung, Marker-gestützte Selektion für monogene und polygene Merkmale. Nutzung pflanzengenetischer Ressourcen: Wildarten, ex-situ und in-situ-Erhaltung, on-farm-Management. Züchtung für marginale Standorte mit Beispielen aus gemäßigten und tropischen Breiten. Dieses Modul und das Modul "Genetic Principles of Plant Breeding" ergänzen sich wechselseitig.	4 SWS
Prüfung: Klausur (Gewicht: 80%, Dauer: 90 Minuten) und Präsentation, Referat oder Korreferat (Gewicht: 20%, Dauer: ca. 20 Minuten) **Prüfungsanforderungen:** Grundlagen zu: Populationsgenetik, Einsatz von Markern in der Pflanzenzüchtung, Konzepte zur Nutzung Pflanzengenetischen Ressourcen. Gute Kenntnisse: 'Pre-Breeding', Kategorien und Methoden der Pflanzenzüchtung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** apl. Prof. Dr. Wolfgang Link
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen Module M.Agr.0057: Plant Virology	6 C 6 WLH
Learning outcome, core skills: Knowledge in classical and molecular Plant Virology, Learning of practical plant virus detection methods with electron-optical methods, immunological methods. Deduction of scientific questions and hypotheses and critical review of methods applied based on personal lab experience.	**Workload:** Attendance time: 80 h Self-study time: 100 h
Course: Plant Virology (Internship, Lecture) *Contents*: Lecture: systematics, vectors, modes of transmission, genome organisation, gene expression strategies, control strategies Practical course: learning of diagnostic methods, symptom recognition, immunogical and molecular detection methods	6 WLH
Examination: Written exam (45 minutes, weighing 50%) and term paper (max. 20 pages, weighing 50%) **Examination prerequisites:** Regular participation at the practical course following the lecture **Examination requirements:** Understanding of the imparted detection methods and knowledge about virus biology.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Mark Varrelmann
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 16	

Georg-August-Universität Göttingen **Modul M.Agr.0058: Plant herbivore interactions** *English title: Plant-Herbivore Interactions*	6 C 4 SWS
Lernziele/Kompetenzen: Kenntnisse komplexer Wechselwirkungen zwischen Pflanzen und herbivoren Insekten. Ableitung wissenschaftlicher Fragestellungen und kritische Bewertung von angewendeten Methoden durch Erarbeitung eines eigenen Seminarbeitrages zu aktuellen Forschungsergebnissen.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
Lehrveranstaltung: Plant herbivore interactions (Vorlesung, Seminar) *Inhalte*: Das Modul beschäftigt sich mit der Wechselwirkung zwischen Pflanzen und herbivoren Insekten. Die Diversität der beteiligten Organismen und der Lebensgemeischaften werden dargestellt. Auf der Seite der Pflanzen werden die verschiedenen Abwehrstrategien unter Einschluss der Resistenzmechanismen gegenüber Fraßfeinden exemplarisch vorgestellt. Die sensorischen Ausstattungen der herbivoren Insekten zur Erkennung der Pflanzen werden beschrieben. Multiple Interaktionen zwischen Pflanzen, Fraßfeinden und natürlichen Gegenspielern sowie die Anwendungsmöglichkeiten werden diskutiert. Schließlich werden die Wechselbeziehungen zwischen Pflanzen und blütenbestäubenden bzw. blütenbesuchenden Insekten behandelt. Im Rahmen des Semiarteils werden von den Studierenden jeweils aktuelle Forschungsergebnisse vorgestellt und im Zusammenhang mit den in den Vorlesungen behandelten Themen diskutiert.	4 SWS
Prüfung: Klausur (Gewicht: 67%, Dauer: 45 Minuten) und Präsentation, Referat oder Korreferat (Gewicht: 33%, Dauer: ca. 20 Minuten) **Prüfungsvorleistungen:** Teilnahme an den Seminaren und Bearbeitung und Vorstellung eines Seminarbeitrages **Prüfungsanforderungen:** Umfassende Kenntnisse der wesentlichen Faktoren der Wirtspflanzenwahl herbivorer Insekten, Abwehrstrategien der Pflanzen, Determinanten für herbivore Lebensgemeinschaften an spezifischen Pflanzen, multitrophische Interaktionen zwischen Pflanzen, herbivoren Insekten und Gegenspielern; Wechselbeziehungen zwischen Pflanzen und Bestäubern.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Michael Georg Rostás
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

20	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.Agr.0059: Präzise bedarfsorientierte Prozesssteuerung in der Nutztierhaltung (PLF)
English title: Precision Livestock Farming</td><td>6 C
4 SWS</td></tr>
</table>

<table>
<tr><td>Lernziele/Kompetenzen:
Die Studierenden erlernen vorhandenes Wissen in der Komplexität einer wissenschaftlichen Fragestellung zu integrieren und fundierte, wissenschaftliche Beurteilungen selbständig zu entwickeln. Sie lernen außerdem, in klarer Form mit Fachvertretern Probleme und Ergebnisse auf wissenschaftlichem Niveau auszutauschen.</td><td>Arbeitsaufwand:
Präsenzzeit:
64 Stunden
Selbststudium:
116 Stunden</td></tr>
</table>

<table>
<tr><td>Lehrveranstaltung: Präzise bedarfsorientierte Prozesssteuerung in der Nutztierhaltung (PLF) (Vorlesung, Exkursion, Seminar)
Inhalte:
Basisprinzip und methodische Grundlagen (Fuzzy Logic, neuronale Netzwerke) für Precision Livestock Farming; Sensoren (Biosensoren und Sensortechnik), Monitoring und Steuerung von Produktionsprozessen (IR-Thermografie, NIR/MIR, digitale Bildanalyse, Analyse der Vokalisation, Body Condition Scoring). Anwendungen im Bereich der Milchviehhaltung, Schweine- und Geflügelhaltung sowie der Stoffzusammensetzung.</td><td>4 SWS</td></tr>
<tr><td>Prüfung: Mündlich (ca. 30 Minuten)
Prüfungsvorleistungen:
Die Abhaltung eines deutschsprachigen Referats im Rahmen einer 30-minütigen Präsentation einschl. Diskussion, basierend auf einer vorgegebenen englischsprachigen wissenschaftlichen Publikation.
Prüfungsanforderungen:
Grundlegende Kenntnisse bezüglich aller als Stoffgebiet geltenden Dokumente und Lehrinhalte, die im Rahmen der Vorlesungen bzw. der Präsentationen angeboten werden (Basisprinzip und methodische Grundlagen (Fuzzy Logic, neuronale Netzwerke) für Precision Livestock Farming; Sensoren (Biosensoren und Sensortechnik), Monitoring und Steuerung von Produktionsprozessen (IR-Thermografie, NIR/MIR, digitale Bildanalyse, Analyse der Vokalisation, Body Condition Scoring). Anwendungen im Bereich der Milchviehhaltung, Schweine- und Geflügelhaltung sowie der Stoffzusammensetzung)</td><td>6 C</td></tr>
</table>

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse aus den im Modul "Grundlagen der Agrartechnik" behandelten Themenbereichen werden erwartet.
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. agr. Sabrina Elsholz
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 36	

Georg-August-Universität Göttingen **Modul M.Agr.0060: Produktion, Investition und Risiko in der Landwirtschaft** *English title: Production, Investment and Risk in Agriculture*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erwerben das methodische Rüstzeug zur Lösung praktischer, quantitativ handhabbarer Planungsprobleme unter Berücksichtigung von Unsicherheit. Sie sind in der Lage, das sich im Einzelfall stellende Problem zu identifizieren und die zur Problemlösung geeigneten Techniken zu identifizieren und anzuwenden. Sie werden dadurch in die Lage versetzt, auch komplexe betriebliche Probleme zu durchdringen und zu lösen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Produktion, Investition und Risiko in der Landwirtschaft (Vorlesung, Übung) *Inhalte*: Da Planung definitionsgemäß zukunftsorientiert ist, kommt dabei der Berücksichtigung von Unsicherheit eine besondere Bedeutung zu. Im Mittelpunkt dieses Moduls steht deshalb die Unternehmerfunktion "Planung" unter besonderer Berücksichtigung von Risiko bzw. Unsicherheit. Es werden ausgewählte Techniken zur Lösung gut strukturierter und quantitativ handhabbarer Planungsprobleme in landwirtschaftlichen Betrieben diskutiert, die eine Berücksichtigung von Unsicherheit erlauben. Es weiterer Schwerpunkt liegt auf dem Management von Preis-, Mengen- und Finanzrisiken. Zu den Lehrinhalten zählen: • Gestaltung des Produktionsprogramms inkl. Risk-Programming • Investitionstheorie inkl. stochastische Simulation • Neue Investitionstheorie und stochastisch-dynamische Programmierung • Finanzierungsentscheidungen in Unternehmen inkl. Leverage-Effekt • Innerbetriebliche und marktbasierte Risikomanagementinstrumente	4 SWS
Prüfung: Mündlich (ca. 25 Minuten) **Prüfungsvorleistungen:** Schriftliche Prüfung (20 Minuten). Es darf keine Prüfung im Modul M.Pferd.0002 oder M.SIA.E13M abgelegt worden sein. **Prüfungsanforderungen:** Grundlegende Kenntnisse in folgen den Bereichen: • Risk-Programming • Stochastische Simulation • Fexible Investitionsplanung • Definition und Wirkungsweise von Risikomanagementinstrumenten • Vertiefte MS-EXCEL-Fertigkeiten	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Oliver Mußhoff

Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 150	

Bemerkungen: Es darf keine Prüfung in den Modulen M.Pferd.0002 oder M.SIA.E13M abgelegt worden sein.

Georg-August-Universität Göttingen **Modul M.Agr.0061: Projektpraktikum Naturschutz in der Agrarlandschaft** *English title: Practical Course Nature Conservation in Agricultural Landscapes*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden sollen lernen, wie man sich selbständig eine innovative Fragestellung erarbeitet und wie ein Versuchsdesign ausschauen kann, das zur Beantwortung dieser Frage geeignet ist. Die Erfahrung mit selbständiger Anlage und Auswertung von Experimenten ist eine elementare Grundlage für wissenschaftliches Arbeiten, wie es letztlich bei der Masterarbeit gefordert ist. Zudem erlaubt die kritische Diskussion der Vorgehensweise, die Glaubwürdigkeit von wissenschaftlichen Arbeiten und Gutachten besser zu beurteilen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Projektpraktikum Naturschutz in der Agrarlandschaft (Praktikum, Seminar) *Inhalte*: Selbständige Erarbeitung von Problemstellungen und Versuchen zur Fragen des Naturschutzes in der Agrarlandschaft. Die Studierenden erarbeiten eine innovative Fragestellung und ein zum Testen der jeweiligen Hypothesen geeignetes Versuchsdesign. Der Versuchsplan wird im Plenum vorgestellt und diskutiert. Die Feld- und Laborexperimente finden danach weitgehend selbständig statt. Die statistische Auswertung der Ergebnisse wird Teil eines Protokolls, das wie eine wissenschaftliche Arbeit aufgebaut sein soll (Einleitung, Methoden, Ergebisse, Diskussion). Bei allen Schritten findet eine intensive Betreuung und Anleitung statt.	4 SWS
Prüfung: Hausarbeit (max. 20 Seiten, 70%) und Präsentation, Referat oder Korreferat (ca. 15 Minuten, 30%) **Prüfungsanforderungen:** Erfahrung mit selbständiger Anlage und Auswertung von Experimenten. Kenntnisse zur statistischen Auswertung der gewonnen Ergebnisse. Referat: In einem 12-minutigen Referat werden die Ergebnisse der Felduntersuchungen präsentiert und kritisch diskutiert. Dies beinhaltet neben einer kurzen Einleitung die Darstellung der Untersuchungshypothesen, Feld-/Labormethoden, statistische Datenauswertung und eine Diskussion der Ergebnisse unter Einbeziehung von Sekundärliteratur, wie z.B. wissenschaftlichen Fachpublikationen (30% der Modulnote). Hausarbeit: In einer schriftlichen Hausarbeit (Umfang max. 20 Seiten) werden die Versuche im Stil einer wissenschaftlichen Veröffentlichung dargelegt. Die Hausarbeit wird hierbei gegliedert in: Zusammenfassung, Einleitung, Hypothesen, Methoden, Resultate, Diskussion und Quellen. Neben formalen Aspekten (z.B. Darstellung der Ergebnisse, Orthografie, korrekte Zitierweise) steht insbesondere die Diskussion der eigenen Ergebnisse unter Berücksichtigung der wissenschaftlichen Fachliteratur im Fokus der Prüfungsanforderungen (70% der Modulnote).	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Westphal
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0064: Qualitätsbildung und Nacherntetechnologie pflanzlicher Produkte entlang der Wertschöpfungskette** *English title: Quality formation and post-harvest technology of plant products along the value chain*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden besitzen Kenntnisse über die Wechselwirkungen zwischen Qualitätsmerkmalen, deren Beeinflussung durch Faktoren in der Vorernte und Nachernteverfahren sowie über deren Anwendung in der landwirtschaftlichen Praxis. Sie sind in der Lage, die Qualität von pflanzlichen Produkten, den Einfluss verschiedener Faktoren in der Vorernte (z.B. Trockenheit und Düngung), und den Einsatz verschiedener Nachernteverfahren in unterschiedlichen Bereichen der Wertschöpfungskette zu bewerten. Weiterhin werden sie befähigt sich mit Fachvertretern über Informationen, Ideen, Probleme und Lösungen auszutauschen und Informationen kritisch zu bewerten.	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
Lehrveranstaltung: Qualitätsbildung und Nacherntetechnologie pflanzlicher Produkte entlang der Wertschöpfungskette (Vorlesung, Seminar) *Inhalte*: Am Beispiel von Getreide, Kartoffeln, Zuckerrüben, Obst und Gemüse: • Qualitätsbeeinflussende Faktoren in der Vorernte • Nacherntephysiologie und Nachernteverfahren • Qualitätsmanagementsysteme • Kritische Bewertung von Papers und sachlicher Austausch von Standpunkten in einem Journalclub	4 SWS
Prüfung: Klausur (60 Minuten) **Prüfungsvorleistungen:** bestehen des Journalclubs ohne Note (besteht aus 1 Gutachten max 5 Seiten und 1 Präsentation/Diskussion 25 min) **Prüfungsanforderungen:** Darstellung des Einflusses von Faktoren in der Vorernte auf die Qualitätsbildung pflanzlicher Produkte und Nachernteverfahren zur Qualitätserhaltung von landwirtschaftlichen Gütern. Darstellung und Bewertung von Qualitätsmanagementsystemen in der Landwirtschaft.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundkenntnisse der Pflanzeninhaltsstoffe werden vorausgesetzt
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Susanne Neugart
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 60	

Georg-August-Universität Göttingen **Modul M.Agr.0065: Qualitätsmanagement Futtermittel** *English title: Quality Management of Feeds*	6 C 4 SWS
Lernziele/Kompetenzen: Vertieftes Wissen auf dem Gebiet des Umganges mit Futtermitteln unter Beachtung aktueller futtermittelrechtlicher Bestimmungen (Lebensmittel- und Futtermittelgesetzbuch, EU-Futtermittelhygieneverordnung) für spätere Tätigkeiten als Futtermittelunternehmer der Primärproduktion (Landwirtschaft) oder der gewerblichen Herstellung, Behandlung, Lagerung und Beförderung von Futtermitteln. Einordnung der Futtermittel aus globaler, volkswirtschaftlicher und betriebswirtschaftlicher Sicht sowie als erstes Glied der Lebensmittelkette. Befähigung zur Durchsetzung von Qualitätsmanagementsystemen (Futtermittel- und Lebensmittelsicherheit, vorbeugender Verbraucherschutz). Übungen (komplexe Futterqualitätsbeurteilung, Futteroptimierung und Fütterungscontrolling) vertiefen die Fähigkeiten. Durch zusammenfassende Ergebnisinterpretationen bzw. durch Übernahme von themenbezogenen Referaten werden Wissensaneignung und Kommunikationsfähigkeit gefördert. Die integrierte Exkursion trägt dazu bei, die Erkenntnisse zu vertiefen und die Aufgaben und Probleme des betrieblichen Qualitätsmanagements praxisnah zu vermitteln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Qualitätsmanagement Futtermittel (Vorlesung, Exkursion, Übung) *Inhalte*: Globale und volkswirtschaftliche Bedeutung von Futtermitteln für Nutztierfütterung und Bioenergiegewinnung; Struktur, Aufgaben und Verpflichtungen der Futtermittelwirtschaft im Rahmen der Lebensmittelkette; Futtermittelrechtliche Rahmenbedingungen für Herstellung (Primärproduktion, Verarbeitung, Behandlung), Lagerung, Handel und Einsatz von Futtermitteln; Futtermittelrecht und Lebensmittelrecht unter dem Aspekt von Sicherheit (Qualitätsgarantie und Rückverfolgbarkeit) und Verbraucherschutz-Risiken und Präventionen; Futtermittelqualität: Qualitätskriterien, Einflussfaktoren, Qualitätsbewertung und Restriktionen beim Futtermitteleinsatz; Qualitätsmanagement in der Futtermittel-Primärproduktion: Prozessqualität bei Erzeugung (einschl. Be- und Verarbeitung), Konservierung, Lagerung und Verfütterung; Qualitätsmanagement bei Herstellung und Handel von Futtermitteln (Einzel- und Mischfuttermittel, einschl. Behandlungsverfahren, Mischprozess, Lagerung, Beförderung und Deklarationsvorschriften); Qualitätsmanagementsysteme für Futtermittelunternehmen: Qualitäts- und Gütesiegel, Anerkennungs- und Zertifizierungsvorschriften, Kontroll- und Überwachungssysteme, Futteroptimierung / Fütterungscontrolling im Prozess der Qualitätssicherung; Futtermittelhygiene: Kontaminationsquellen, Qualitätsbeeinflussung durch Erzeugung, Lagerung und Behandlung; Futterzusatzstoffe im Prozess des Futterqualitätsmanagements: Zulassungsbestimmungen, Wirkungsspektren, Einsatzrichtlinien und Sicherheitsanforderungen; Maßnahmen zur Verbesserung der Qualität tierischer Rohprodukte; Amtliche Futterqualitätsüberwachung: Nationales	4 SWS

Kontrollprogramm zur Futtermittel- und Lebensmittelsicherheit - Risikobewertung, Risikomanagement und Präventionsmaßnahmen.	
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Vertieftes Wissen in folgenden Bereichen: Nationaler und internationaler Futtermittelmarkt; Futtermittel in der Lebensmittelkette; Zusammenhänge zwischen Futtermittel- und Lebensmittelsicherheit; Rechtliche Vorschriften für Futtermittelunternehmen; Konsequenzen für das Qualitätsmanagement im Futtermittelsektor (Primärfuttermittel, Handelsfuttermittel, Futterzusatzstoffe); Grundsätze der Futtermittelqualitätsbewertung (Einflussfaktoren, Qualitätserhaltung, Qualitätsverbesserung); Qualitätsmanagementsysteme im Futtermittelsektor; Qualitätssicherung im Futtermittelunternehmen; Futteroptimierung; Futterqualitätsverbesserung durch spezielle Behandlungsverfahren, Futtermittelhygienevorschriften; Maßnahmen zur Produktqualitätsverbesserung	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse aus dem Themenbereich des BSc. Agrarwissenschaften werden erwartet
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jürgen Hummel
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Agr.0066: Qualitätsmanagement tierischer Produkte** *English title: Quality Management of Food of Animal Origin*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden können differenziert das Konzept „Qualität“ erläutern. Sie besitzen Kenntnisse über verschiedene Qualitätssicherungs-/Managementsysteme entlang der Wertschöpfungskette für tierische Produkte. Sie kennen die wichtigsten Gebote/Verbote der EU- bzw. der nationalen Lebensmittelhygienegesetzgebung und können Verfahren zur sensorischen Qualitätssicherung erläutern. Sie können sich mit Partnern des vor- und nachgelagerten Bereiches der Landwirtschaft auf wissenschaftlichem Niveau austauschen und komplexe endogene bzw. exogene Einflussfaktoren auf die Qualität tierischer Erzeugnisse analysieren und zielorientiert lenken.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Qualitätsmanagement tierischer Produkte (Vorlesung, Exkursion) *Inhalte*: Die Studierenden lernen die Grundbegriffe der Qualitätssicherung und der diversen Verfahren (z.B. HACCP, ISO 9001:2015, IFS). Die zentrale Stellung der Qualitätspolitik als Führungsaufgabe von Unternehmen entlang der Wertschöpfungskette von tierischen Erzeugnissen wird vermittelt. Es werden Fragen des präventiven Qualitätsmanagements (Auffinden von CP und CCP) hinsichtlich der Hygienerisiken und Qualitätssicherung behandelt und Fallbeispiele von Rohwarenspezifikation und Produktentwicklung in der Erzeugungskette diskutiert. Es wird in Grundzügen die Bedeutung der EU-Lebensmittelhygienegesetzgebung bzw. deren nationale Umsetzung (z.B. LFGB) für die tierische Produktion bis hin zur Direktvermarktung vermittelt. Es werden Methoden zur sensorischen Qualitätssicherung vorgestellt. Zudem werden Qualitätsmanagementfaktoren aus der Sicht der Tierernährung betrachtet. Im Rahmen von Exkursionen bzw. Gastvorträgen lernen die Studierenden die Umsetzung bzw. die Relevanz des theoretisch vermittelten Wissens in praxi kennen.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Komplexe Kenntnisse von Qualitätssicherungssystemen, Produkthaftung, Risikoanalyse, CCP, EU-Hygienepaket, Direktvermarktung, Zertifizierung und Qualitätslenkung tierischer Produkte, Sensorische Methoden zur Qualitätssicherung/-kontrolle.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse aus den im Modul "Qualität tierischer Erzeugnisse" behandelten Themenbereichen werden erwartet.
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Daniel Mörlein
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 200	

Georg-August-Universität Göttingen **Modul M.Agr.0068: Quantitativ-genetische Methoden der Tierzucht** *English title: Quantitative-genetical Methods in Animal Breeding*	6 C (Anteil SK: 6 C) 6 SWS

Lernziele/Kompetenzen: Alle in der Theorie behandelten Konzepte werden anhand von Beispielen aus der Zuchtpraxis illustriert. In den Übungen werden zum Teil EDV-Programme genutzt. Die Studierenden sind in der Lage, auch komplexere tierzüchterische Problemstellungen auf der Basis solider Methodenkenntnisse zu bearbeiten und die züchterische Relevanz neuer Technologien korrekt einzuschätzen.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Quantitativ-genetische Methoden der Tierzucht (Vorlesung, Übung) *Inhalte*: In dieser Lehrveranstaltung werden die wesentlichen quantitativ-genetischen Konzepte vorgestellt, die der Tierzucht zu Grunde liegen. Ausgehend von den molekulargenetischen Grundlagen und den Regeln der Wahrscheinlichkeitsrechnung werden die wichtigsten genetischen Mechanismen innerhalb von Populationen anhand des Ein-Locus-Modells dargestellt. Behandelt werden Gen- und Genotypfrequenzen unter Gleichgewichtsbedingungen und in dynamischen Systemen, wie etwa unter Selektion. Aus Frequenzen und Genotypwerten werden Varianzen und Kovarianzen sowie die daraus abgeleiteten Populationsparameter wie Heritabilität und genetische Korrelation entwickelt. Auf dieser Basis wird die Selektionstheorie eingeführt und es wird der Selektionsindex zur Kombination von Merkmalen und von Informationsquellen vorgestellt. Das Konzept der Heterosis als Grundlage der Kreuzungszucht wird erläutert und es werden verschiedene Strategien der Kreuzungszucht dargestellt. An ausgewählten Beispielen wird erläutert, wie neue Technologien (z.B. im Reproduktionsbereich) und Informationsquellen (z.B. molekulargenetische Marker) in der Tierzüchtung genutzt werden können.	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Wesentliche Kenntnisse in Populationsgenetik in Ein-Locus-Modellen sowie genetischer Parameter, Zuchtwertschätzung, Selektionsindex, in der Ableitung wirtschaftlicher Gewichte und von Kreuzungsparametern.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Ahmad-Reza Sharifi
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

90	

Georg-August-Universität Göttingen **Modul M.Agr.0069: Reproduktionsbiotechnologie** *English title: Reproduction Biotechnology*	6 C 5 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen detaillierte Kenntnisse über reproduktions-biotechnologische Methoden und Verfahren, die in der modernen Tierzucht, beim Menschen und in der wissenschaftlichen Grundlagenforschung angewendet werden. Der Einsatz, die Chancen und die Risiken dieser Techniken werden speziesspezifisch diskutiert und gewertet. Den Studierenden wird die gesellschaftspolitische Relevanz des Vorlesungsinhaltes vermittelt und Argumentationsschienen vorgestellt. Darüber hinaus erwerben die Studierenden Kompetenzen in der Erschließung und Diskussion reproduktionsbiotechnologischer Themen und deren mündlicher Präsentation unter Verwendung aktueller wissenschaftlicher Literatur.	**Arbeitsaufwand:** Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden

Lehrveranstaltung: Reproduktionsbiotechnologie (Vorlesung, Exkursion, Übung) *Inhalte*: Fortpflanzungsbiotechnologische Verfahren: Brunstkontrolle; Trächtigkeitsdiagnose; Besamung; Geburtssteuerung; Hormonelle Steuerung der Brunst und Geburt; Embryotransfer, In Vitro Produktion; Ovum Pick Up und Intrafollikulärer Oozyten Transfer; Kryokonservierung von Embryonen; Klonierung von Tieren; Stammzellen; Präimplantationsdiagnostik; Mikroinjektion; Transgene Tiere; Genome Editing; Chimären, Gesetzte und Verordnungen; Ethische Betrachtung und Gesellschaftliche Relevanz fortpflanzungsbiologischer Verfahren. Fundierte Diskussion wissenschaftlicher Inhalte auf der Basis aktueller Literatur. Aufbereitung und Präsentation wissenschaftlicher Fakten.	5 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Seminarpräsentation (25 Minuten). Regelmäßige Teilnahme an den Seminaren und Exkursionen zu reproduktions-biotechnologischen Verfahren. **Prüfungsanforderungen:** Detaillierte Kenntnisse über reproduktionsbiotechnologische Methoden und Verfahren, die in der modernen Tierzucht, beim Menschen und in der Wissenschaft angewendet werden. In der Prüfung werden Wissens-, Könnens-, und Transferfragen gestellt, die die Lehrinhalte abdecken und die Reflexion des Erlernten voraussetzen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse aus den Modulen „Physiologische Grundlagen von Fortpflanzung und Leistung bei Nutzsäugern“ werden empfohlen.
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Michael Hölker
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul M.Agr.0070: Reproduktionsmanagement** *English title: Management of Reproduction*	6 C 5 SWS
Lernziele/Kompetenzen: Den Studierenden werden die Bedeutung der Einflussfaktoren und die sachlichen Zusammenhänge der verschiedenen Wissensdisziplinen am Zustandekommen des Reproduktionserfolges/Reproduktionsmisserfolges vermittelt. Die Studierenden wenden die erlernten grundlegenden und detaillierten Kenntnisse zum Reproduktionsgeschehen beim landwirtschaftlichen Nutztier fallspezifisch an. Dabei schulen sie ihre analytischen Fähigkeiten sowie die Fähigkeiten zum selbstständigen Arbeiten, die sprachliche und schriftliche Ausdrucksfähigkeit und ihre Sozialkompetenz. Durch eigene Präsentationen wird das Zeitmanagement und die Argumentation in der Diskussion mit relevanten Fachbegriffen erlernt.	**Arbeitsaufwand:** Präsenzzeit: 64 Stunden Selbststudium: 116 Stunden
Lehrveranstaltung: Reproduktionsmanagement (Vorlesung, Exkursion) *Inhalte*: Verfahren des Fortpflanzungsmanagements (Ernährung, Hygiene, Haltung, Leistung, Genetik und Einsatz von Biotechniken) bei großen und kleinen Wiederkäuern, Schwein, Pferd, Kaninchen, Geflügel und Süßwasserfischen; Ursachen von Fruchtbarkeitsstörungen bei landwirtschaftlichen Nutztieren.	5 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Regelmäßige Teilnahme an den Exkursionen **Prüfungsanforderungen:** Grundlegende und detaillierte Kenntnisse zum Reproduktionsgeschehen beim landwirtschaftlichen Nutztier. In der Prüfung werden Wissens-, Könnens- und Transferfragen aus den Bereichen Tierernährung, Tierhygiene, Tierhaltung, Physiologie, Genetik und Biotechniken gestellt und das Verständnis des Zusammenwirkens dieser Wissenschaftsgebiete auf den Bereich des Reproduktionsmanagements abgefragt. Mit dem Referat wird das problemlösende Herangehen der Studierenden an aktuelle Probleme der Reproduktion landwirtschaftlicher Nutztiere überprüft.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse aus den in den Modulen "Physiologische Grundlagen von Fortpflanzung und Leistung bei Nutzsäugern" und "Biologie der Tiere" behandelten Themenbereichen werden erwartet.
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Michael Hölker
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**

Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul M.Agr.0074: Spezielle Nutztierethologie** *English title: Special Ethology of Farm Animals*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben in diesem Modul wissenschaftliche Grundlagen zur Durchführung von ethologischen Untersuchungen an Nutztieren. Die Studierenden verstehen die Planung, Durchführung und Auswertung von ethologischen Untersuchungen und erwerben zentrale Kompetenzen in der Darstellung von ethologischen Studien (schriftlich und mündlich). Sie können sich auf der Basis dieser Kenntnisse in diesem Bereich selbständig weitergehend einarbeiten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Spezielle Nutztierethologie (Vorlesung, Seminar) *Inhalte*: Vermittlung von ethologischen Methoden. Durchführung von Studienprojekten mit eigenen ethologischen Beobachtungen. Hierzu werden als Grundlagen vermittelt: etholgische Methoden, Versuchsplanung, statistische Methoden, Datenauswertung und Präsentation der Ergebnisse.	4 SWS
Prüfung: Mündliche Prüfung (Gewicht: 35%, Dauer: ca. 20 Minuten), Projektarbeit (Gewicht: 65%, Umfang: max. 8 Seiten) **Prüfungsanforderungen:** Grundlagenkenntnisse: Methoden der Verhaltensbeobachtung; Planung, Durchführung und Auswertung von ethologischen Untersuchungen; Analyse von Forschungsergebnissen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Imke Traulsen
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0075: Spezielle Tierhygiene, Tierseuchenbekämpfung und Tierhaltung** *English title: Special Animal Hygiene, Control of Epidemics and Livestock Husbandry*	6 C 6 SWS
Lernziele/Kompetenzen: Die Studierenden können auf dem aktuellen Stand von Forschung und Praxis moderne Hygiene- und Haltungskonzepte entwickeln und sie in komplexe Hygiene- und Qualitätssicherungsprogramme integrieren. Sie können die erlernten Fähigkeiten in einem multidisziplinären Feld der Tierseuchenbekämpfung sicher anwenden und vermitteln.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Spezielle Tierhygiene, Tierseuchenbekämpfung und Tierhaltung (Praktikum, Vorlesung) *Inhalte*: Die art- und umweltgerechte Tierhaltung und Hygiene der landwirtschaftlichen Nutztiere sind in der Praxis untrennbar miteinander verbunden. Die Schnittstelle wird bei intensiven wie auch bei extensiven Haltungsverfahren insbesondere im Bereich der Vorbeugung gegenüber Infektionskrankheiten und der Seuchenbekämpfung deutlich. Das Modul versucht deshalb die thematischen Beziehungen der Einzeldisziplinen funktionell zu verknüpfen, die maßgeblich für den Hygiene- und Gesundheitsstatus unserer Nutztiere verantwortlich sind. Im Zuge der Entwicklung intensiver Haltungsverfahren mit hohen Tierdichten veränderte sich gleichzeitig das Spektrum der Erreger in den Beständen. Neben eindeutigen und klar zu diagnostizierenden Erkrankungen finden sich zunehmend multikausale oder multifaktorielle Symptomenkomplexe, die sehr schnell den gesamten Bestand erfassen können und nicht nur auf einen einzigen Infektionserreger zurückzuführen sind. In solchen Fällen eröffnet ein qualifiziertes Hygiene- und Herdenmanagement gleichzeitig aber auch die größten Erfolgsaussichten für eine gesunde Tierpopulation. In diesem Modul werden deshalb ausgewählte und für die einzelnen Produktionsrichtungen praxisrelevante Infektionskrankheiten der Nutztiere vorgestellt und mit den Haltungssystemen in Beziehung gesetzt. Diese Kenntnisse münden in das grundlegende Verständnis von modernen Konzepten für staatliche und freiwillige Programme in der Tierseuchenbekämpfung (z.B. BHV1, BVD, Leukose/Brucellose, Blauzungenkrankheit, Paratuberkulose, Aujeszky, Schweinepest, Geflügelpest etc.). Sie stellen aber auch die Grundlagen für die Etablierung von Qualitätssicherungssystemen in Hygieneprogrammen der Nutztierproduktion. Rechtliche Aspekte werden dabei ebenfalls berücksichtigt. Neben der Gesunderhaltung der Tiere leisten optimierte Tierhygiene und Tierhaltung einen wichtigen Beitrag für die Minimierung von Umweltschäden (Luft-, Boden-, Wasser- und Umwelthygiene). In begleitenden Praktika und bei praktischen Übungen im Feld werden unterschiedliche Produktionseinheiten mit ihren Haltungsformen vorgestellt und das jeweilige Hygienemanagement analysiert. Jungtier-, Euter- und Klauenhygiene, Hygiene der	6 SWS

Melktechnik, Fütterungshygiene sowie Besamungs- und Geburtshygiene sind dabei die Schwerpunkte.	
Prüfung: Klausur (90 Minuten, 70%), Hausarbeit (Gruppenarbeit, Entwicklung eines Biosicherheitssystems, 30%) **Prüfungsanforderungen:** Grundlegende Kenntnisse der Biologie und Pathogenese von Tierseuchenerregern, der freiwilligen Hygieneprogramme und staatlich gesteuerten Tierseuchenbekämpfungsprogramme, der Umwelthygiene und der Analyse von Tierhaltungssystemen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Rafael Mateus Vargas
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 60	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.Agr.0076: Statistische Nutztiergenetik
English title: Statistical Genetics of Farm Animals</td><td>6 C
4 SWS</td></tr>
</table>

<table>
<tr><td>Lernziele/Kompetenzen:
Ziel dieser Lehrveranstaltung ist es, die wesentlichen Auswertungsmethoden und -techniken in den Tierzuchtwissenschaften zu verstehen und anwenden zu lernen.
In Rahmen des Moduls wird den Studierenden die Theorie der mathematischen und statistischen Methoden und Modellbildungen auf dem Gebiet der Nutztiergenetik vermittelt. Sie werden in die Lage versetzt, relevante Methoden und Modelle für wissenschaftliche Fragestellungen zu identifizieren und die damit verbunde Aufbereitung und Auswertung von phänotypischen und genetischen Daten komplexer Strukturen eigenständig durchzuführen. An Hand praxisrelevanter und aktueller Fragestellungen und unter der Anwendung von statistischen Softwarepaketen erlernen die Teilnehmer dann die praktische Anwendung von Analysemethoden und Ergebnisinterpretationen.</td><td>Arbeitsaufwand:
Präsenzzeit:
56 Stunden
Selbststudium:
124 Stunden</td></tr>
</table>

<table>
<tr><td>Lehrveranstaltung: Statistische Nutztiergenetik (Vorlesung, Übung)
Inhalte:
Es werden die Theorie und die praktischen Anwendungen von allgemeinen und verallgemeinerten linearen Modellen (GLMs) und allgemeinen und verallgemeinerten linearen gemischten Modellen (GLMMs) mit differenten Linkfunktionen sowie von multivariaten Analyseverfahren in folgenden Themengebieten gelehrt:
Varianz- und Kovarianzanalyse zur Schätzung von fixen Effekten bei phänotypischen und molekularbiologischen Daten in einem faktoriellen Versuchsdesign
Schätzung der Varianzkomponenten und genetischen Parameter (REML, BLUP) unter der Anwendung von gemischten Modellen
Genetische Assoziationsstudien und Kandidatengenanalysen bei Leistungsmerkmalen und funktionalen Merkmalen
Diversitätsanalysen mittels Schätzung genetischer Distanzen und Konstruktion phylogenetischer Bäume auf der Grundlage von Genotyp- und Sequenzdaten
Die erlernten Methoden werden anschließend anhand von konkreten Beispieldatensätzen praktisch angewandt. Hierbei kommen u.a. die Programme
R, SAS, AS-REML, PHYLIP, STRUCTURE zum Einsatz.</td><td>4 SWS</td></tr>
<tr><td>Prüfung: Klausur (100 Minuten)
Prüfungsanforderungen:
Die Prüfung besteht aus einer computergestützten Auswertung und Interpretation von Beispieldaten (100 min).
Vertiefte Kenntnisse in den Bereichen:
BLUP-Zuchtwertschätzung
REML-Varianzkomponentenschätzung (jeweils für normalverteilte und nicht normalverteilte Beobachtungen)
Parametrische und nichtparametrische Methoden der Genkartierung,
Schätzung genetischer Distanzen und Konstruktion phylogenetischer Bäume.</td><td>6 C</td></tr>
</table>

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Ahmad Reza Sharifi
Angebotshäufigkeit: jedes 4. Semester; Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0077: Themenzentriertes Seminar** *English title: Themes Centered Seminar*	6 C (Anteil SK: 6 C) 4 SWS
Lernziele/Kompetenzen: Die Studierenden sollen lernen, wie man die agrarökonomischen Inhalte, die im bisherigen Studium in diversen Modulen erarbeitet wurden, integrativ auf ein aktuelles Forschungsfeld anwendet. Damit ist verbunden, dass die Studierenden sich breit bilden und die integrative Zusammenführung von Ergebnissen aus verschiedenen Themenbereichen erlernen. Die Erarbeitung von einigen Themen kann auch die Anwendung von empirischen Methoden (z.B. Statistik und Ökonometrie, einfache Simulationsmodelle) voraussetzen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Themenzentriertes Seminar (Blockveranstaltung, Seminar) *Inhalte*: In diesem inhaltlich breit angelegten Wahlpflichtmodul, das von DozentInnen aus der Ökonomie gestaltet wird, erfolgt eine Erarbeitung eines aktuellen Themas aus dem Bereich der Agrarökonomie. Das Modul wird von jeweils zwei DozentInnen aus den Studienschwerpunkten Agribusiness und WiSoLa im Wechsel angeboten. Die Arbeitsthemen umfassen je nach Spezialisierung der jeweiligen DozentInnen Agrarpolitik und Marktlehre, die Entwicklung des Agrarsektors in Entwicklungs- und Transformationsländer, die Entwicklung von ländlichen Räumen, Welternährung und Weltagrarhandel, Management in der Landwirtschaft sowie in den der Landwirtschaft vor- und nachgelagerten Bereichen, Risikomanagement, Qualitätsmanagement, Ressourcenmanagement und Umweltökonomie, Organisation sowie Agrarmarketing. Jeder Teilnehmer / jede Teilnehmerin fertigt eine Seminararbeit zu einem aktuellen Thema an und trägt die Ergebnisse dieser Seminararbeit mündlich vor.	4 SWS
Prüfung: Hausarbeit (Gewicht: 50%, Umfang: max. 15 Seiten) und Präsentation, Referat oder Korreferat (Gewicht: 50%, Dauer: ca. 20 Minuten) **Prüfungsanforderungen:** Einführende Kenntnisse bezüglich der Erarbeitung von Hintergrundwissen und Methoden zum Thema, so dass sich die Studierenden sich selbstständig einen thematischen Schwerpunkt erarbeiten können. Dieser Schwerpunkt wird in einem Referat mit anschließender Diskussion präsentiert.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Rainer Marggraf
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

40	

Bemerkungen:
Die Prüfenden sind jeweils zwei Dozentinnen/Dozenten aus den Studienschwerpunkten Agribusiness und WiSoLa im Wechsel.

Georg-August-Universität Göttingen **Modul M.Agr.0078: Umweltindikatoren und Ökobilanzen** *English title: Environmental Indicators and Ecological Valuation*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben theoretische Grundlagen sowie Kenntnisse des Methoden-Instrumentariums zur Erarbeitung von Umweltindikatoren und Ökobilanzen. Es werden Kompetenzen für die forschungsbasierte Analyse und Bewertung der Umweltauswirkungen landwirtschaftlicher Produktionsformen vermittelt. Die Studierenden können auf der Basis dieser Kenntnisse z.B. mit Hilfe von Felddaten in diesen Bereich selbständig spezielle Fragestellungen bearbeiten. Sie erlernen, komplexe Zusammenhänge der umweltgerechten und nachhaltigen Landwirtschaft zu kommunizieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Umweltindikatoren und Ökobilanzen (Vorlesung, Exkursion, Übung, Seminar) *Inhalte*: Methoden zur Erstellung von Wirkungserhebungen, Entwicklung von Methoden zur integrierten Bewertung, Ökobilanzierung für verschiedene Produktionssysteme, Öko-Audit von Betrieben, Bewertung von Produktionssystemen, Erstellung und Bewertung von Stoff- und Energiebilanzen. In Übungen werden Computer-Modelle eingesetzt.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlagenkenntnisse der Bewertungsmethoden, der Entwicklung von Umweltindikatoren, von Ökobilanzen, der Bewertung von Produktionssystemen, der Stoff- und Energiebilanzen und der Ableitung von Modellen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Imke Traulsen
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul M.Agr.0080: Untersuchungsmethoden (mit Labortierernährung und Praktikum)** *English title: Investigation Methods (with laboratory animal husbandry and practicals)*	6 C 4 SWS
Lernziele/Kompetenzen: Durch verstärkte Entwicklung von methodischen Kompetenzen wird eine komplexe Entwicklung der Urteilsfähigkeit in Fachfragen gefördert. Über Übungsteile wird insbesondere die selbständige Aneignung von Wissen und Können erhöht. Zugleich werden die Voraussetzungen zur eigenständigen Forschungsarbeit im Fachgebiet verbessert.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Untersuchungsmethoden (mit Labortierernährung und Praktikum) (Vorlesung, Übung) *Inhalte*: Grundlagen zu Untersuchungsmethoden am Tier und im Labor (Futter, Tierprodukte, Exkrete, physiologische Proben). Folgende Inhalte werden behandelt: Methoden der Verdaulichkeitsmessung in-vivo und in-vitro, Stoffwechselversuche, Schätzung des Energiegehaltes von Futtermitteln und Tierprodukten. Proteinqualitätsbewertung, Kalorimetrie, Respirationsmessungen, Erfassung des mikrobiellen Stoffwechsels im Pansen, ausgewählte Analytik zur Bestimmung der Nährstoffe, Einsatz von Labortieren, Ernährungsansprüche von Labor- und Heimtieren, Statistische Aspekte der Planung und Auswertung von Versuchen, Methoden der Grundfutterqualitätsbewertung, Futtermittelmikroskopie – Grundlagen und Anwendungen.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlagenkenntnisse in folgenden Bereichen: Ernährungsphysiologische Untersuchungs- und Auswertungsmethoden und ihre Anwendung bei unterschiedlichen Tierarten; Bewertung der Resultate von Stoff- und Energiebilanzmessungen an Nutztieren; Grundsätze der Ernährung verschiedener Labortiere; spezielle Anwendungen der Bausteinanalyse von Eiweißen und Fetten; Einsatz spezieller Methoden bei Grundfutterqualitätsbeurteilung, Pansensimulation, Futtermittelmikroskopie und biostatistischer Versuchsplanung und -auswertung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse aus den im Modul "Ernährungsphysiologie" behandelten Themenbereichen werden erwartet.
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Frank Liebert
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 8	

Georg-August-Universität Göttingen **Modul M.Agr.0081: Verarbeitung pflanzlicher Produkte** *English title: Processing of Vegetable Products*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erhalten einen Einblick in die Erfordernisse der Lebensmittelproduktion. Es wird ihnen vermittelt, welche Anforderungen aus Sicht der Verarbeitung an die Rohstoffqualität gestellt werden. Damit werden sie befähigt, auf der Grundlage multidisziplinärer Kenntnisse, wissenschaftlich fundierte Entscheidungen zu treffen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Verarbeitung pflanzlicher Produkte (Vorlesung, Übung) *Inhalte*: Besonderheiten der Lebensmittelverarbeitung, thermische und mechanische Verfahren, Getreidetechnologie (erste und zweite Verarbeitungsstufe: Vermahlung, Backwarenherstellung), Nährmitteltechnologie (Reisverarbeitung, Teigwarenherstellung, Herstellung Extrudererzeugnisse), Ölsaatenverarbeitung Verarbeitung von Obst und Gemüse (Saftgewinnung, Herstellung von Konserven aus Obst und Gemüse, Sauerkrautherstellung), Übungen und Demonstrationen zu ausgewählten Verarbeitungsschritten, Exkursion	4 SWS
Prüfung: Klausur (60 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse in folgenden Bereichen: • Darstellung der Besonderheiten der Lebensmittelproduktion • Erläuterung von Verfahren der ersten und zweiten Verarbeitungsstufe von Getreide/Nährmitteltechnologie/-Verarbeitung von Obst und Gemüse unter Berücksichtigung der Anforderungen an die Qualität von Rohstoffen und Endprodukten • Erläuterung von thermischen, chemischen, physikalischen und mechanischen Verfahren der Lebensmittelproduktion	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundkenntnisse der Pflanzeninhaltsstoffe werden vorausgesetzt
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Tobias Pöhnl
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 70	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.Agr.0082: Verfahren in der Tierhaltung
English title: Animal Husbandry Systems</td><td>6 C
4 SWS</td></tr>
</table>

<table>
<tr><td>Lernziele/Kompetenzen:
Die Studierenden erlernen die Durchführung einer Planung von Produktionssystemen landwirtschaftlicher Nutztiere. Mit wissenschaftlich fundierten Hintergründen können sie eigenständig Haltungssysteme entwickeln und bewerten. Sie können dies in einer Gruppe von Fachkundigen klar und wissenschaftlich nachvollziehbar darstellen.</td><td>Arbeitsaufwand:
Präsenzzeit:
56 Stunden
Selbststudium:
124 Stunden</td></tr>
</table>

<table>
<tr><td>Lehrveranstaltung: Verfahren in der Tierhaltung (Vorlesung, Übung)
Inhalte:
Planung von Haltungsverfahren für landwirtschaftliche Nutztiere
Bewertungsverfahren von Produktionsformen und -abläufen bei ldw.
Nutztieren
Analyse von Produktionssystemen landwirtschaftlicher Nutztiere
Bewertung von Managementmaßnahmen.</td><td>4 SWS</td></tr>
<tr><td>Prüfung: Mündlich (ca. 25 Minuten)
Prüfungsanforderungen:
Kenntnisse in der Bewertung von Produktionsformen und -abläufen bei landwirtschaftlichen Nutztieren; Fähigkeit der Analyse von Produktionssystemen landwirtschaftlicher Nutztiere sowie der Bewertung von Managementmaßnahmen.</td><td>6 C</td></tr>
</table>

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse aus dem Bereich Nutztierhaltung werden erwartet.
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. agr. Sabrina Elsholz
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 27	

Georg-August-Universität Göttingen **Modul M.Agr.0086: Weltagrarmärkte** *English title: World Agriculture Markets and Trade*	6 C 6 SWS
Lernziele/Kompetenzen: Die Studierenden kennen die wichtigsten Modelle zur Erklärung internationalen Handels von Agrarprodukten. Sie sind in der Lage, populistische Argumente gegen den Freihandel als solche zu entlarven. Sie können beurteilen, ob es Gründe dafür gibt, bei Agrarprodukten vom Postulat des Freihandels abzuweichen, z.B. um die positiven externen Effekte der Landwirtschaft zu honorieren, die Versorgung mit Nahrungsmitteln sicherzustellen, Öko- und Sozialdumping abzuwehren oder verzerrte Weltmarktpreise für Agrarprodukte zu korrigieren.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Weltagrarmärkte (Vorlesung, Übung) *Inhalte*: Das Modul befasst sich mit der Situation an den Weltagrarmärkten und den Eingriffen der Agrar- und Handelspolitik in diese Märkte, basierend auf einer Einführung in die Theorie des internationalen Handels.	6 SWS
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsanforderungen:** Handelstheoretische Grundlagen: Ricardo, Heckscher-Ohlin-Vanek, Viner; Empirische Tests von Handelstheorien; unvollkommener Wettbewerb auf internationalen Märkten; Grundlagen von Gravitätsgleichungen; Institutionen und Organisationen auf Weltagrarmärkten; Agrarhandelsliberalisierung auf multilateraler (WTO) und bilateraler Ebene; spezielle Politikmaßnahmen im internationalen Agrarhandel	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Bernhard Brümmer
Angebotshäufigkeit: jedes Sommersemester; Göttingen	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 90	

Bemerkungen:
Es finden parallel zwei Übungen statt (dt/engl).

Georg-August-Universität Göttingen **Modul M.Agr.0088: Hymenoptera-Bestimmungskurs** *English title: Idenification of Hymenoptera*	3 C

Lernziele/Kompetenzen: Die Studierenden sollen diese bedeutende Tiergruppe kennen lernen. Dazu gehört zum einen ein breiter Überblick, zum anderen aber auch die konkrete Beschäftigung mit ausgewählten Vertretern dieser Gruppe. Ziel ist ein tiefes Verständnis für die riesige Artenvielfalt, die auch mit einer Vielfalt an Funktionen (Prädation, Bestäubung, Parasitismus) einhergeht und auch für angewandte Fragestellungen (Bestäubung von Kulturpflanzen, biologische Kontrolle von Schadorganismen) wichtig ist.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 30 Stunden

Lehrveranstaltung: Hymenoptera-Bestimmungskurs (3C) (Blockveranstaltung, Praktikum, Vorlesung, Seminar) *Inhalte*: In diesem Block-Kurs wird die Insektenordnung der Hymenoptera vorgestellt. Die Hymenoptera stellen rund ein Viertel aller Tierarten in Mitteleuropa und sind damit die mit Abstand größte Insektenordnung. Zu den Hymenoptera (Hautflügler) gehören funktionell sehr wichtige Gruppen wie Prädatoren (Ameisen, Faltenwespen), Bestäuber (Bienen) und Parasitoide (Schlupfwespen). Mit einführenden Vorlesungen, Demonstrationen von diversen Materialien und selbständigem Bestimmen von lebendigem und totem Material wird sich diese wichtige Tiergruppe erarbeitet.	
Prüfung: Vortrag (40%, ca. 15 Minuten Vortrag und ca 10 Minuten Diskussion), Protokoll (60%, max. 20 Seiten) **Prüfungsanforderungen:** Literaturrecherche zum Thema und Erarbeitung von einführendem Hintergrundwissen; Führen eines Protokolls, Erarbeitung und Präsentation in einem Referat	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Westphal
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0089: Ökologisches Seminar** *English title: Ecology Seminar*	3 C 2 SWS
Lernziele/Kompetenzen: Die Studierenden sollen sich mit der aktuellen Literatur befassen und lernen, welche Stärken und Schwächen die vorgestellten Arbeiten haben. Zudem sollen sie mit eigenen Vorträgen und in der Diskussion lernen, ihre Ansichten argumentativ zu vertreten und sich mit kontroversen Haltungen auseinanderzusetzen. Darüber soll ein tieferes Verständnis und eine größere inhaltliche Sicherheit bei aktuellen ökologischen Themen erreicht werden.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Ökologisches Seminar (Seminar) *Inhalte*: In diesem Seminar werden aktuell Themen der Ökologie und Biodiversitätsforschung durch die TeilnehmerInnen vorgestellt und diskutiert. Dazu gehören zum einen kontroverse Diskussionen in der aktuellen Literatur zu Fragen wie dem Zusammenhabng von Biodiversität und Ökosystemfunktionen in Agrarsystemen oder zur Bedeutung des Globalen Wandels für Ökosysteme. Zum anderen werden anhand aktueller Forschungsarbeiten Problem des Versuchsdesigns und der statistischen Auswertung diskutiert. In regelmässigen Abständen gibt es auch Vorträge von eingeladenen Gästen aus dem In- und Ausland.	2 SWS
Prüfung: Hausarbeit (max. 15 Seiten) **Prüfungsanforderungen:** Erarbeitung von Hintergrundwissen zu verschieden Themen der Ökologie und der Biodiversitätsforschung,die Fähigkeit, eigene Ansichten argumentativ zu vertreten und Hintergrundwissen zu Versuchsdesign und statistischer Auswertung zu erlangen. Hausarbeit: Teilnahme an mind. 10 Seminarterminen und Protokoll von mind. 5 Seminarthemen von max. 15 Seiten Gesamtlänge.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Westphal
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Agr.0092: Steuern und Taxation** *English title: Taxes and Taxation*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben das methodische Rüstzeug zur Lösung praktischer steuerlicher Fragestellungen und von Taxationsaufgaben. Sie sind in der Lage, das sich im Einzelfall stellende Problem zu identifizieren und adäquat zu lösen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Steuern und Taxation (Vorlesung) *Inhalte*: Im Mittelpunkt dieses Moduls stehen Steuer- und Taxationsfragen im Allgemeinen sowie die jeweiligen landwirtschaftlichen Spezifika im Besonderen. Zu den Lehrinhalten zählen: • Grundzüge der Ermittlung der einzelnen Steuern • Praktische steuerliche Fragestellungen in der Landwirtschaft • Anlässe und Aufgaben der Taxation • Methoden der Taxation • Praktische Bearbeitung von Taxationsaufgaben in der Landwirtschaft	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** • Allgemeine steuerliche Grundlagen • steuerliche Spezifika in der Landwirtschaft • Allgemeine Taxationsgrundlagen • landwirtschaftliche Spezifika bei der Taxation	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Oliver Mußhoff
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 100	

Georg-August-Universität Göttingen **Modul M.Agr.0094: Basics of Molecular Biology in Crop Protection** *English title: Basics of Molecular Biology in Crop Protection*	6 C 4 SWS

Lernziele/Kompetenzen: Verständnis der Grundlagen wichtiger agrarwissenschaftlicher Untersuchungsmethoden wie ELISA und PCR, Verständis der biochemischen und molekularbiogischen Grundlagen von Züchtung und pflanzlicher Resistenzen gegen Schaderreger.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Grundlagen und Anwendung der Molekularbiologie in der Phytomedizin (Vorlesung) *Inhalte*: In der landwirtschaftlichen Forschung und Diagnostik werden vermehrt biochemische und molekularbiologische Methoden verwendet. Die Vorlesung vermittelt die Grundlagen, die zum Verständnis dieser Methoden notwendig sind, und bereitet auf weiterführende Praktika und Vorlesungen vor. Inhalte sind: Cytologie, Aufbau der Zellwände verschiedener Organismengruppen, Struktur und Funktion von Makromolekülen (Proteine, DNA, RNA, Kohlenhydrate), Funktion und Regulation von Enzymen, DNA-Replikation, Transkription und Translation, Regulationsmechanismen, Einführung in das Prinzip grundlegender molekularer Nachweismethoden, Lipide und Membranen, Phytohormone, ausgewählte Sekundärstoffe.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Aufbau von Makromolekülen, Ausgangsstoffe, typische Bindungstypen, Funktion, Bedeutung, Regulationsmechanismen auf Protein- und Nukleinsäureebene, Phytohormone, Sekundärstoffwechsel	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Anke Sirrenberg
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0099: Projektarbeit** *English title: Project Work*	9 C 6 SWS
Lernziele/Kompetenzen: Fachbezogene Kenntnisse des jeweiligen Arbeitgebietes, soziale Kompetenzen (Arbeitsorganisation, Teamarbeit, Interdisziplinäres Arbeiten, Flexibilität), praktisch methodische Kompetenzen	**Arbeitsaufwand:** Präsenzzeit: 180 Stunden Selbststudium: 90 Stunden
Lehrveranstaltung: Projektarbeit (Praktikum) *Inhalte*: Projektarbeit in unterschiedlichen Einrichtungen des vor- und nachgelagerten Bereichs, z. B. Forschungseinrichtungen, Industrie, Verwaltung, Verbände, Beratung, Politik. Einblick in Arbeitsmethoden, Aufgaben, Berufsalltag. Erwerb praktisch-anwendungsbezogener Kenntnisse. Die Anfertigung der Projektarbeit auf landwirtschaftlichen Betrieben ist nicht möglich.	6 SWS
Prüfung: Hausarbeit (max. 20 S, 50 %) und Präsentation (ca. 45 Minuten; 50 %) **Prüfungsanforderungen:** Nachweis von fachbezogene Kenntnisse des Arbeitgebietes, fundierte Kenntnisse von Arbeitsorganisation, Teamarbeit, Interdisziplinäres Arbeiten, Flexibilität, praktisch methodische Kompetenzen	9 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Anne-Katrin Mahlein
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen Module M.Agr.0101: Soil and Plant Hydrology	6 C
Learning outcome, core skills: Students will learn the principles of soil and plant water relations and they will be introduced to experimental techniques such as probes and techniques to measure soil and plant water fluxes. Students will learn how to model water uptake and transpiration by either using existing numerical codes or developing new ones. Student will be updated to the state of the art of the research by discussing selected key papers. The module aims at preparing and stimulating students for independent research.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Soil and Plant Hydrology (Lecture, Exercise) *Contents*: How does water flow across soil and plants? This is a central question in water use efficiency, agriculture and soil conservation. This module attempts to explain: how hydraulic properties of soil and roots control water availability to plants how plants modify and adapt to the soil properties how to optimize irrigation for increasing water storage in the root zone and reducing water loss by evaporation and leaching. Topics of the module are: Principles of water dynamics in soils: water flow in unsaturated porous media; soil structure; evaporation. Principles of water transport in plants: water and solute flow paths at the cell, tissue, and all plant level; root conductivity measurements. Soil-plant interactions: soil properties affecting root growth; hydraulic behavior of the rhizosphere. Soil and water resources management: water scarcity; irrigation.	4 WLH
Examination: Oral examination (approx. 45 minutes) **Examination requirements:** Students must know: the physics of water flow in soils and roots; what are the soil and root properties controlling plant uptake; how to measure them; how to model them; and how these properties are related to water use efficiency.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** UnivProf.Dr. Martin Maier
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0103: Mineralstoffernährung von Kulturpflanzen unter verschiedenen Klima-, Standort- und Umweltbedingungen** *English title: Mineral Nutrition of Crops under Different Climatic and Environmental Conditions*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erlangen Kenntnis der charakteristischen Eigenschaften und Besonderheiten in den Nährstoffkreisläufen von Ökosystemen verschiedener Klimazonen. Sie entwickeln Verständnis für wichtige Prozesszusammenhänge zwischen abiotischen Standortvoraus-setzungen, Prozessen in Böden und den Auswirkungen auf die Nährstoff-aufnahme durch Pflanzen. Sie kennen Adaptionsmechanismen. Sie kennen Grundlagen und verschiedene Anwendungsbeispiele für den Einsatz stabiler Isotope, um die o.g. Prozesse zu studieren. Fähigkeit zur Recherche und Analyse von wissenschaftlichen Texten und zur Präsentation im Kreis der Mitstudierenden	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Mineralstoffernährung von Kulturpflanzen unter verschiedenen Klima-, Standort- und Umweltbedingungen (Vorlesung, Seminar) *Inhalte*: Nährstoffdynamik in Agrarökosystemen verschiedener Klimazonen, Interaktionen zwischen Klima, Nährstoffverfügbarkeit und Nährstoffaufnahme von Pflanzen, Kriterien nachhaltiger Bewirtschaftung, Biologische N2-Fixierung, Mycorrhiza, Symbiosen, Spurengasemissionen, Konzepte zur effizienten, ressourcenschonenden Ernährung von Kulturpflanzen unter verschiedenen Umweltbedingungen, Auswirkungen unterschiedlichen Nährstoffmanagements, Reaktionen bzw. Anpassungsstrategien von Pflanzen an besondere Umweltbedingungen wie saure, saline und überstaute Böden Grundlagen „Stabile Isotope", Abgrenzung gegen Radionuklide, Isotopfraktionierung, Nutzung natürlicher Isotopenhäufigkeiten und Tracer-Techniken für Studien der Nährstoff- und Wassernutzungs-effizienz, Isotop-Analytik, Authentizitätsprüfung, Quantifizierung der Stickstoffnutzungseffizienz und der biologischen N2-Fixierung	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Teilnahme an Seminarvorträgen **Prüfungsanforderungen:** Kenntnis der zentralen Charakteristika der Nährstoffdynamik in verschiedenen Klimazonen, der jew. Hauptproblemfelder im Hinblick auf Bodenfruchtbarkeit und Nährelementversorgung und der pflanzlichen Anpassungsmechanismen. Grundlagenwissen Stabilisotop-Tracer-Techniken, Natürliche Abundanzen, Fraktionierung und deren Anwendung in Kulturpflanzenforschung	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Klaus Dittert

Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 45	

Bemerkungen: Modul kann nur absolviert werden, wenn bisher keine Prüfung im Modul M.Agr.0180 erfolgt ist.

Georg-August-Universität Göttingen **Modul M.Agr.0106: China Economic Development: From an agricultural economy to an emerging economy** *English title: China Economic Development: From an Agricultural Economy to an Emerging Economy*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erfahren Einzelheiten über die ökonomische Wandlung Chinas und lernen grundlegende ökonomische Konzepte kennen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: China Economic Development: From an agricultural economy to an emerging economy (Vorlesung, Seminar) *Inhalte*: Der Kurs ist konzipiert für Masterstudenten der Universität Göttingen. Es werden die Erfahrungen und Lehren aus der ökonomischen Entwicklung Chinas behandelt, indem die Ursachen für die Wandlung von der landwirtschaftlich geprägten zur aufstrebenden Volkswirtschaft erklärt werden.	4 SWS
Prüfung: Präsentation, Referat oder Korreferat (ca. 25 Minuten, Gewichtung 50%) und Hausarbeit (max 15 Seiten, Gewichtung 50%) **Prüfungsanforderungen:** Darstellung und kritische Diskussion eines wissenschaftlichen Aspekts des ökonomischen Wandels in China.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Xiaohua Yu
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Modul M.Agr.0108: Internationale Rechnungslegung im Agribusiness** *English title: International Accounting in Agribusiness*	6 C 3 SWS
Lernziele/Kompetenzen: Grundkenntnisse im Bereich der Konzernrechnungslegung und internationaler Rechnungslegung von Unternehmen des Agribusiness	**Arbeitsaufwand:** Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden
Lehrveranstaltung: Internationale Rechnungslegung im Agribusiness (Vorlesung) *Inhalte*: Im Rahmen dieser Veranstaltung werden die Grundzüge der internationalen Rechnungslegung, soweit sie für die Agrar- und Ernährungswirtschaft relevant sind, vermittelt. Schwerpunkte des Vorlesungsstoffes sind historische sowie aktuelle Entwicklungen der internationalen Rechnungslegung, strukturelle Unterschiede zwischen angelsächsischen und europäischen Finanzmärkten, die Abgrenzung des Konzerns vom Einzelunternehmen, Grundlagen und Funktionen des Konzernabschlusses, besondere Aspekte der (Konzern-)Rechnungslegung nach IFRS sowie die Tendenz zur Konvergenz zwischen interner und externer Rechnungslegung.	3 SWS
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsanforderungen:** Wissen der für die Agrar- und Ernährungswirtschaft relevanten Grundzüge der internationalen Rechnungslegung und der Konzernrechnungslegung von Unternehmen des Agribusiness.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Achim Spiller
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Module M.Agr.0111: Applied Equilibrium Models for Agri-Food Markets**	6 C
Learning outcome, core skills: Good background in micro-economic theory; Presentation of scientific results from literature review including technical details of model formulations; Critical analysis and discussion of modeling results; Interest to learn and to apply the economic modeling software GAMS.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Applied Equilibrium Models for Agri-Food Markets (Block course, Exercise, Seminar) *Contents*: The seminar will introduce to the application of partial (PE) and general (GE) equilibrium models for agricultural and food markets. The first part of the course on PE models will provide a stepwise development of a multimarket model for agricultural and processed food products, and will provide the basis for the development of a general equilibrium model in the second part. Models developed in this seminar will be formulated in GAMS. Along with the technical instruction, various policy simulations of the models developed will provide students with hands-on experience. This experience will be extended by a literature review of existing model analyses (AGLINK, FAPRI, ESIM). The seminar will be held in English.	WLH
Examination: Oral Presentation (approx. 20 minutes) **Examination requirements:** Presentation and discussion of modeling results in English. Understanding of principles of equilibrium models for agri-food markets.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Martin Banse
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0114: Sicherheitsbewertung biotechnologischer Verfahren in der Pflanzenzüchtung** *English title: Biosafety Evaluation of Biotechnological Approaches in Plant Breeding*	6 C 4 SWS
Lernziele/Kompetenzen: Vertieftes Verständnis von Sicherheitsbewertung und Sicherheitsmanagement biotechnologischer (einschließlich gentechnischer) Verfahren in der Pflanzenzüchtung; Erkennen komplexer Zusammenhänge zwischen Sicherheitsforschung, Sicherheitsbewertung und -management sowie zwischen gesetzlichen Regulierungen und wissenschaftlich-technischem Fortschritt auf nationaler und internationaler Ebene.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Anwendung und Rechtsrahmen gentechnischer Verfahren (Vorlesung, Exkursion) *Inhalte*: Sicherheitsbewertung, Beantragung und Durchführung gentechnischer Arbeiten in Labor und Gewächshaus: Rechtsrahmen, Kriterien, Voraussetzungen;Monitoring der Auswirkungen der Markteinführung gentechnisch veränderter Pflanzen: Zielsetzung, Rechtsrahmen, kritische Betrachtung (Zielstellung, Aufwand, Nutzen) ausgewählter Methoden;Gesetzliche Regelungen/Voraussetzungen für Freisetzungsversuche; Durchführung der Sicherheitsbewertung und Versuchsplanung, Beantragung, Versuchsdurchführung; Bedeutung und Notwendigkeit von Koexistenz, Situation in Deutschland/Europa, Confinement-Strategien.	
Lehrveranstaltung: Anwendung und Rechtsrahmen biotechnologischer Verfahren allgemein (Vorlesung, Exkursion) *Inhalte*: Anwendung und juristische Bewertung biotechnologischer Verfahren in der Pflanzenzüchtung; Sicherheitsforschung, -bewertung und -management; Pflanzen als Produktionsplattform - Perspektiven und Sicherheitsbewertung.	
Lehrveranstaltung: Neue Züchtungsverfahren in der Anwendung (Vorlesung, Exkursion) *Inhalte*: Gene targeting/editing, gene drive; vergleichende Auswirkung „klassischer“ und „neuer“ Züchtungsmethoden; Pflanzengenom- und Transkriptomanalyse, Datenbanken; next generation sequencing, Bioinformatik; Bewertung und Regulierung ausgewählter Züchtungsverfahren	
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Anwendung und Rechtsrahmen gentechnischer Verfahren: Vertieftes Verständnis von gentechnischem Arbeiten in Labor und Freiland; Fallstudien; Monitoring und Koexistenz, Planung und Durchführung gentechnischer Versuche im Freiland; Anwendung und Rechtsrahmen biotechnologischer Verfahren allgemein:	6 C

Vertieftes Verständnis von Sicherheitsbewertung und Sicherheitsmanagement biotechnologischer Verfahren in der Pflanzenzüchtung; Fallstudien GV Pflanzen für Futter- und Nahrungsmittelanwendungen, GV Pflanzen als Produktionsplattform für industrielle & pharmazeutische Produkte sowie Energie Neue Züchtungsverfahren in der Anwendung: Vertieftes Verständnis und Sicherheitsbewertung neuer Züchtungsverfahren einschließlich Gentechnik und genome editing; Fallstudien vergleichende Sicherheitsbewertung und Bioinformatik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Ralf Wilhelm
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul M.Agr.0117: Lebensmittelsensorik und Konsumentenforschung** *English title: Consumer Research and Sensory Analysis of Food*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden wissen über Aufbau und Funktion der menschlichen Sinnesorgane sowie über die physiologischen und psychologischen Vorgänge, die zu den Sinneswahrnehmungen führen, Bescheid. Die Studierenden erhalten die Kompetenz, sensorische Prüfverfahren zur Beurteilung landwirtschaftlicher Primärerzeugnisse bzw. von Lebensmitteln tierischer oder pflanzlicher Herkunft dem Prüfzweck entsprechend auszuwählen und anwenden zu können und entsprechende Fragestellungen selbständig bearbeiten, auswerten und präsentieren zu können. Die Studierenden kennen die sensorischen Prüfmethoden und die Methoden zur statistischen Auswertung der Tests. Sie wissen, anhand welcher Kriterien die für einen Test am besten geeignete Methode ausgewählt wird. Die Studierenden kennen die zugrunde liegenden DIN-Vorschriften für sensorische Prüfverfahren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Lebensmittelsensorik und Konsumentenforschung (Praktikum, Vorlesung, Übung) *Inhalte*: Die Vorlesung befasst sich mit verschiedenen Aspekten der Humansensorik: Grundlagen der Sinnesphysiologie und Sinnespsychologie Sensorische Testverfahren (Prüfzweck, Durchführung, Auswertung), Sensorik in Marketing, Produktentwicklung & Agrarforschung, Besonderheiten bei der Beurteilung pflanzlicher und tierischer Produkte. Die Übungen im Sensoriklabor dienen a) der Umsetzung des erworbenen Wissens bei praktischen Tests und b) der Schulung der eigenen sensorischen Grundfähigkeiten. Dabei werden die Sinneswahrnehmung geschult und verschiedene sensorische Prüfmethoden zur Untersuchung von Lebensmitteln tierischer und pflanzlicher Herkunft vorgestellt und eigenständig durchgeführt sowie statistisch ausgewertet (u.a. mit R).	4 SWS
Prüfung: Hausarbeit (2x max. 3 Seiten; 40%) und Präsentation (ca. 15 min.; 60%) (90 Minuten) **Prüfungsvorleistungen:** Teilnahme an den praktischen Übungen **Prüfungsanforderungen:** Wissen über Sinnesphysiologie; Sensorische Prüfverfahren, statistische Auswertung	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Daniel Mörlein
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module M.Agr.0118: Applied Microeconometrics**	6 C 4 WLH
Learning outcome, core skills: Learn the basic logics behind each econometric model, understand the tests for model specification, and appropriately explain the model outputs in connection to economic theories.	**Workload:** Attendance time: 40 h Self-study time: 140 h
Course: Applied Microeconometrics" (Internship, Lecture, Seminar) *Contents*: This course mainly teaches how to correctly apply basic econometric models to studying specific research questions for master level students in agricultural economics, agribusiness, and related programs at the University of Goettingen. The main software package used in this course will be STATA.	4 WLH
Examination: Written examination (120 minutes, 70%) and term paper (max. 12 pages, 30%) **Examination requirements:** 1. Understand the econometric models taught in the class 2. Use Stata skillfully	6 C

Admission requirements: Ökonometrie I / Econometrics I	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Xiaohua Yu
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Modul M.Agr.0119: Corporate Social Responsibility im Agribusiness: Gesellschaftliche Erwartungen als Managementherausforderung** *English title: Corporate Social Responsibility in Agribusiness: Societal Expectations and Management Concepts*	6 C 4 SWS

Lernziele/Kompetenzen: • Qualitative und quantitative Methoden der Markt-, Konsum- und Medienforschung kennen lernen und in einer Projektarbeit anwenden können • Ausgewählte aktuelle Forschungsergebnisse zu den gesellschaftlichen Erwartungen an die Branche verstehen • Strategien und Instrumente des CSR-Managements • Ansätze der Unternehmensethik und der Öffentlichkeitsarbeit	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Corporate Social Responsibility im Agribusiness: Gesellschaftliche Erwartungen als Managementherausforderung (Seminar) *Inhalte*: Das Modul greift die vielfache Kritik an modernen Produktionsmethoden der Agrar- und Ernährungswirtschaft auf. Auf Basis empirische Studien und multivariater Analysemethoden wird zunächst vorgestellt, wie gesellschaftliche Erwartungshaltungen ermittelt werden können (Dr. Inken Christoph). Auf dieser Basis werden im zweiten Teil Fragen der unternehmerischen Verantwortung (CSR), der Unternehmensethik und Reaktionsmuster im Management einschließlich der Öffentlichkeitsarbeit vorgestellt (Dr. Anke Zühlsdorf). Begleitend bearbeiten die Studierenden in einem Projekt eine aktuelle Fragestellung des CSR-Managements (Prof. Spiller).	4 SWS
Prüfung: Mündliche Prüfung (20 Minuten, 50%) und Präsentation (ca. 20 Minunten) inkl. schriftlicher Ausarbeitung (max. 15 Seiten) (Gewichtung 50%). **Prüfungsanforderungen:** Das Modul besteht aus einem theoretischen Teil und einem anwendungsorientierten Projekt, in demdie Studierenden beiintensiver Betreuung eine aktuelle Themenstellung selbständig bearbeiten und präsentieren. In der mündlichen Prüfungwerden die erworbenen theoretischen Grundlagen geprüft. In der Hausarbeit stellen die Studierenden auf Basis ihrererworbenen Theoriekenntnisse und der Ergebnisse der Projektarbeit in einer Hausarbeit eine Lösung für die vertieftbehandelte Fragestellung vor und präsentieren diese in einem Referat.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse der empirischen Sozialforschung inkl. SPSS
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Achim Spiller
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	2 - 4
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Module M.Agr.0120: Molecular Diagnostic and Biotechnology in Crop Protection**	6 C 4 WLH

Learning outcome, core skills: Participants will be able to understand nucleic acid based as well as immunologic diagnostic tools for detection of plant pathogens and pests. More the ability to select appropriate diagnostic techniques and make informed decisions regarding their development and application is one of the core skills. Students shall understand the role of biotechnology in plant protection and resistance breeding to be able to assess the potentials and risks of GM crops and other GMOs in plant protection.	**Workload:** Attendance time: 65 h Self-study time: 115 h

Course: Molecular Diagnostic and Biotechnology in Crop Protection (Lecture) *Contents*: Principles and applications of diagnostic techniques in plant protection with a focus on nucleic acid analysis (characteristics as accuracy, detection level, multiplexing, quantification, portability, and designability). Nucleic acid detection: RT-PCR viruses, group specific primers, multiplex dsRNA-diagnosis (viruses), qPCR (SYBR, TaqMan, fluorophores), Nested-PCR, RFLP, MLSA, ddPCR (phytoplasma), Barcoding (fungi, insects, weeds) SNP-genotyping (KASP, etc.), RCA (DNA viruses, Padlock-probes), Hybridisation (dot-blot viruses, RNAscope, SABER-FISH), DNA-arrays (microarrays), HTS/NGS/ Transcriptomics (Virome/metagenomics analysis, discovery of new virus diseases), Sequencing platforms (Roche 454, Illumina, Solid and Ion Torrent, SMRT and MinION nanopore sequencing), Isothermal amplification techniques (LAMP, RPA, HAD, NASBA), CRISPR based diagnosis (viruses) Molecular detection of specific traits (fungicide, herbicide, insecticide resistance). Protein detection: ELISA, TPIA, LFA, Immune fluorescence, ISEM electron microscopy, confocal microscopy and fluorescent labelled viruses, Immuno(capture)-PCR, Luminex. Biotechnology in plant protection: Crop trait targets, techniques to increase genetic diversity, cisgenesis, NGS and third generation sequencing, omics, genetically modified organisms (GMOs) in engineering resistance to viruses, pests, herbicides, bacterial and fungal pathogens, genome editing tools, applications of RNA interference and epigenome modifications, RNAi machinery, cross-kingdom RNAi, VIGS, HIGS, SIGS, Epigenetics, regulation and public acceptance, risk assessment	4 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Understanding concepts and technical principles of molecular diganostic methods and the applicatoin of molecular markers and plant biotechnology in plant protection. Demonstration of the ability to read primary literature that describes applications of techniques covered by the module	6 C

Admission requirements:	**Recommended previous knowledge:**
none	none

Language: English	**Person responsible for module:** Prof. Dr. Mark Varrelmann
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul M.Agr.0122: Vertriebsmanagement im Agribusiness** *English title: Sales Management in Agribusiness*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden kennen die Strukturen der Landwirtschaft und der Agribusiness-Supply Chain. Sie verstehen das Einkaufsverhalten von Landwirten und anderer Kundengruppen und die Marketingstrategien der Anbieter für die verschiedenen Vorleistungsprodukte. Sie können auf dieser Basis verschiedene Vertriebskonzepte sinnvoll bewerten und situationsadäquat einsetzen. Dies beinhaltet u. a. Kenntnisse zu Organisationsstrukturen im Vertrieb und Einkauf, Vertriebstools, Database- und Customer-Relationship Management, Vertriebscontrolling und Anreizsysteme im Vertrieb. Die Studierenden werden durch das Modul zu einem erfolgreichen Berufseinstieg in den Vertriebsbereich des Agribusiness, der sehr viele Berufspositionen für Hochschulabsolventen bietet, befähigt.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Vertriebsmanagement im Agribusiness (Seminar) *Inhalte*: Die Veranstaltung behandelt: • Strukturentwicklungen in der Landwirtschaft und im Agribusiness • Entwicklung von Vertriebsstrukturen • Theorien und Konzepte des Beschaffungsverhaltens • Einkaufsverhalten von Landwirten • Vertriebsstrategien • Operatives Vertriebsmanagement • Vertriebsorganisation inkl. Key-Account Management • Database- und Customer Relationship Management • Service- und Maintenance-Management • Personalführung und Anreizsysteme im Vertrieb • Vertriebscontrolling	4 SWS
Prüfung: Klausur (60 Minuten, 50%) und Referat (ca. 15 Minuten) mit schriftlicher Ausarbeitung (max. 15 Seiten) (50%) **Prüfungsanforderungen:** Für die Klausur: Kenntnisse über Strukturentwicklungen in der Landwirtschaft und im Agribusiness, über Vertriebsstrategien, über operatives Vertriebsmanagement, über Service- und Maintenance-Management, über Vertriebscontrolling, über Personalführung und Anreizsysteme im Vertrieb und über Database- und Customer Relationship Management. Darüberhinaus Wissen über Vertriebsorganisation inkl. Key-Account Management, über Einkausverhalten von Landwirten, über Theroien und Konzepte des Beschaffungsverhaltens und über Entwicklung von Vertriebsstrukturen. Erstellung einer Hausarbeit auf Basis empirischen Datenmaterials und Erarbeitung/ Vortragen einer Präsentation	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine

Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Achim Spiller
Angebotshäufigkeit: jedes 4. Semester; Start WS 15/16	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 1 - 3
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul M.Agr.0125: Spezielle Wiederkäuerernährung** *English title: Advanced Ruminant Nutrition*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben in diesem Modul spezielle Kenntnisse und ein vertieftes Verständnis der Vormagenfunktion und des Vormagenstoffwechsels des Wiederkäuers, ebenso wie erweiterte Kennnisse zur Fütterung und Ernährung von Wiederkäuern (Versorgungsempfehlungen; Futtermittel; Rationsplanung). Sie können sich in Themen dieses Bereichs selbstständig weitergehend einarbeiten und können wissenschaftliche Ergebnisse zusammenfassend vorstellen und diskutieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Spezielle Wiederkäuerernährung (Vorlesung, Seminar) *Inhalte*: Vermittlung erweiterter verdauungsphysiologischer Grundlagen zu Funktion und Stoffwechsel des Vormagens (Pansenmorphologie; Partikelzerkleinerung; Fermentation; Mikrobenzusammensetzung). Vergleichende Aspekte der Wiederkäuerverdauung und –ernährung. Vermittlung von Kenntnissen zur Fütterung und Rationsgestaltung von Wiederkäuern. Aktuelle Aspekte und Herausforderungen der Wiederkäuerernährung werden vorgestellt.	4 SWS
Prüfung: Klausur (90 Minuten, 60%) und Präsentation (ca. 20 Minuten, 40%) **Prüfungsanforderungen:** Kenntnisse zur Verdauungsfunktion und Fütterung von Wiederkäuern; Befähigung zur Analyse und Vorstellung englischsprachiger wissenschaftlicher Literatur	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse von im Modul Ernährungsphysiologie behandelter Themenkreise
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Jürgen Hummel
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**

Georg-August-Universität Göttingen **Modul M.Agr.0139: Soziologie ländlicher Räume – ländliche Gesellschaft, Landwirtschaft, Ländlichkeit** *English title: Rural Sociology – Rural Society, Agriculture, Rurality*	6 C 4 SWS
Lernziele/Kompetenzen: Herausforderungen und Chancen der ländlichen Entwicklung stehen im Zentrum der Veranstaltung. Ziel ist es, die Studentinnen und Studenten mit den theoretischen und empirischen Grundlagen der ländlichen Soziologie vertraut zu machen, dazu gehören auch Grundkenntnisse in der Demographie, Soziologie sozialer Ungleichheit und Raumordnung. Diskutiert werden aktuelle soziale und politische Entwicklungen (räumliche Polarisierung, Daseinsvorsorge, Neue Ländlichkeit). Dies soll eine differenzierte Betrachtung des „Phänomens ländlicher Raum“ ermöglichen, die zu eigenen Analysen und Bewertungen befähigt.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Soziologie ländlicher Räume – Ländliche Gesellschaft, Landwirtschaft, Ländlichkeit (Seminar) *Inhalte*: Die alte Verbindung von Land, Landwirtschaft und ländlicher Gesellschaft ist brüchig geworden. Die (außerland-)wirtschaftliche und demographische Situation bestimmt zunehmend die Lebensbedingungen der Menschen im ländlichen Raum. Im Ergebnis sind ländliche Räume in Deutschland von großer sozialer und kultureller Vielfalt geprägt. Gibt es überhaupt noch etwas spezifisch Ländliches? Natur, Heimat, Idylle – lediglich Produkte findiger Journalisten und gestresster Städter? Oder ist gerade der ländliche Raum Motor für innovative nachhaltige Lebens- und Wirtschaftsformen? Welche Rolle spielen hier (noch) die landwirtschaftlichen Betriebe?	4 SWS
Prüfung: Präsentation (ca. 45 Minuten, 50%) und Hausarbeit (max. 20 Seiten, 50%) **Prüfungsanforderungen:** Vertiefte Kenntnisse zur Demographie und Sozialstruktur ländlicher Räume, zu Herausforderungen und Chancen ländlicher Entwicklung, zu Empirie und Theorie landsoziologischer Studien.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Claudia Neu
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Bemerkungen:

Die Bereitschaft, an empirischen Feld- und Gemeindestudien mitzuwirken, wird begrüßt. Die Präsentation erfolgt im Seminar.

Georg-August-Universität Göttingen **Modul M.Agr.0142: Projektarbeit in Agribusiness und WiSoLa** *English title: Internship in Agribusiness and Economic and Social Sciences in Agriculture*	12 C 6 SWS
Lernziele/Kompetenzen: Fachbezogene Kenntnisse des jeweiligen Arbeitsgebietes, soziale Kompetenzen, (Arbeitsorganisation, Teamarbeit, Interdisziplinäres Arbeiten, Flexibilität), praktisch methodische Kenntnisse	**Arbeitsaufwand:** Präsenzzeit: 270 Stunden Selbststudium: 90 Stunden
Lehrveranstaltung: Projektarbeit in Agribusiness und WiSoLa (Praktikum) *Inhalte*: Projektarbeit in unterschiedlichen Einrichtungen des vor- und nachgelagerten Bereichs, z. B. Forschungseinrichtungen, Industrie, Verwaltung, Verbände, Beratung, Politik. Einblick in Arbeitsmethoden, Aufgaben, Berufsalltag. Erwerb praktisch anwendungsbezogener Kenntnisse. *Die Anfertigung der Projektarbeit auf landwirtschaftlichen Betrieben ist nicht möglich*	
Prüfung: Hausarbeit (max. 20 Seiten, 50%) und Präsentation (ca. 45 Minuten, 50%) **Prüfungsanforderungen:** Nachweis von fachbezogenen Kenntnissen des Arbeitsgebietes, fundierte Kenntnisse der Arbeitsorganisation, Teamarbeit, Interdisziplinäres Arbeiten, Flexibilität, praktisch methodische Kompetenzen, Mindestdauer von 30 Werktagen in den unterschiedlichen Einrichtungen des vor- und nachgelagerten Bereichs.	12 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Dr. Holger Bergmann
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Modul M.Agr.0145: Datenmanagement und Auswertung pflanzenbaulicher Versuche - Eine Einführung in SAS** *English title: Data Management and Evaluation – An Introduction in SAS*	3 C 2 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen einfache Versuche selbstständig anzulegen und entsprechend auszuwerten sowie Daten für eine effektive statistische Auswertung zu strukturieren und zu verarbeiten. Es wird erlernt statistische Auswertungen zu interpretieren und entsprechend darzustellen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Datenmanagement und Auswertung pflanzenbaulicher Versuche - Eine Einführung in SAS (Blockveranstaltung, Vorlesung, Übung) *Inhalte*: Es werden an konkreten pflanzenbaulichen Beispielen Grundlagen im Umgang mit Software gelegt. • Strukturierung von Daten, Datenmanagement, Funktionen • Graphische Ergebnisdarstellung • Wiederholung von Grundlagen der Statistik in Bezug zur „Versuchsplanung und Auswertung“ • Statistische Auswertung (Univariate Auswertung, Varianzanalyse, Korrelation, Regression, Nichtlineare Regression, Frequenzanalyse, Modelvoraussetzung, Transformationen, Clusteranalyse, …) • Versuchsplanung • Insbesondere stehen der Anwendungsbezug, die Interpretation der SAS Ausgabe sowie das eigene Arbeiten im Vordergrund • Es besteht die Möglichkeit eigene Versuchsdaten auszuwerten	2 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Datenmanagement und Randomisation von Versuchen. Auswertung von Versuchen. Analyse von Zusammenhängen. Die Prüfung findet am PC statt.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Christian Kluth
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

20	

Georg-August-Universität Göttingen **Modul M.Agr.0147: Digitale Technologien in der Pflanzenproduktion** *English title: Digital Technologies in Plant Production*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden kennen die theoretischen Funktionalitäten, Grundlagen und praktischen Konzepte von digitalen Technologien im Bereich Pflanzenproduktion und können mit den erworbenen Kenntnissen Abläufe im Bereich Precision Agriculture und Plant Phenotyping bewerten und gestalten. Die Studierenden kennen technische Funktionsprinzipien von verschiedenen Sensortypen und verstehen Messabläufe und lernen Ansätze, um gewonnene Daten mit geeigneten Methoden zu interpretieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Digitale Technologien in der Pflanzenproduktion (Vorlesung, Exkursion) *Inhalte*: Im Rahmen des Moduls werden den Studierenden ausgewählte digitale Technologien und ihr technisches Umfeld für den Einsatz in pflanzlichen Produktionssystemen vorgestellt. Zunächst werden grundlegende Themen der Anwendungsfelder Precision Agriculture und Pflanzenphänotypisierung, Plattformen und Skalenebenen sowie zu Erhebung, Auswertung und Sicherheit von Daten eingeführt. In einem zweiten Block der Veranstaltung stehen die verschiedenen Sensoren im Vordergrund: Umweltsensorik / Optische Sensoren wie RGB-, multi- und hyperspektrale Technologien / 3D-Technologien, Chlorophyllfluoreszenz und Thermographie / Akustische Sensoren und Kräftemessung / Fernerkundung und Satelliten. In einem dritten Block der Vorlesung werden praktische, zum Teil bereits im Einsatz befindliche Anwendungen vorgestellt: Erfassung der Entwicklung eines Bestands und abiotischem Stress, Fallbeispiele zur Detektion von Pflanzenkrankheiten mittels optischer Sensoren und zu Ertragsparametern und Maschinensensorik mit Feldapplikationen (Vehikel- oder Flugobjekt-gestützt. Berücksichtigt werden Applikationen im Acker-, Obst- und Gemüsebau. 1. Von der Messaufgabe zum Ergebnis (Vorlesung) 2. Sensoren (Vorlesung) 3. Fallbeispiele (Vorlesung) 4. Exkursion	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Verständnis digitaler Methoden und Sensortechnologien sowie funktionaler Zusammenhänge zur Erfassung von Pflanzenstress, in Abhängigkeit von unterschiedlichen Skalenebenen. Kenntnisse über Methoden der Analyse und Interpretation optischer Sensordaten.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine

Sprache: Deutsch	**Modulverantwortliche[r]:** Anne-Katrin Mahlein
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 80	

Bemerkungen: gemeinsame Veranstaltung des IfZ und der Agrartechnik, Prof. A.-K. Mahlein und Prof. F. Beneke

Georg-August-Universität Göttingen **Module M.Agr.0148: Policy Analysis of International Agri-environmental Schemes**	6 C 4 WLH
Learning outcome, core skills: Students gain essential knowledge on the analysis of policy instruments in agri-environmental systems and are capable to apply selected methods and criteria for policy analysis.	**Workload:** Attendance time: 40 h Self-study time: 140 h

Course: Policy analysis of international agri-environmental schemes (Seminar) *Contents*: This module is aimed at analyzing public policies in agri-environmental schemes. The module will • Outline the role of agriculture for positive and negative environmental externalities, e.g. biodiversity loss, climate change, multi-functionality of agriculture • Introduce into governance and policy processes of agri-environmental schemes • Give an overview of policy instruments, such as economic incentives and environmental standards and regulation • Present criteria and methodologies to conduct policy analysis Students will subsequently conduct a small policy analysis of their own interest in the field of agri-environmental policy and incentive instruments (national, EU-level or international level), e.g. EU-CAP, PES schemes, carbon markets in agriculture, sustainability standards, environmental financing, or land-use planning.	4 WLH
Examination: Presentation (approx. 25 min; 30%) and term paper (max. 20 pages; 70%) **Examination requirements:** Students write a seminar paper on the analysis of specific agri-environmental policy measures applying selected evaluation criteria and methods. Subsequently, they present and discuss their findings in class.	6 C

Admission requirements: none	**Recommended previous knowledge:** M.Agr.0124: Environmental Economics and Policy
Language: English	**Person responsible for module:** Prof. Dr. Meike Wollni
Course frequency: each summer semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 2 - 3
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul M.Agr.0149: Ausgewählte Reproduktionsbiotechnologien** *English title: Selective Topics in Livestock Reproduction Physiology*	6 C 6 SWS
Lernziele/Kompetenzen: Das im Modul Reproduktionsbiotechnologie (M.Agr.0069) erworbene theoretische Hintergrundwissen über den Ablauf der Reproduktionsbiotechnologien bei landwirtschaftlichen Nutztieren wird in praktischen Übungen an Nutztierdummies, Nutztieren und durch selbstständige Laborarbeiten vertieft, umgesetzt und geübt. Die Studierenden wenden die Techniken in Form von definierten Versuchsanstellungen an und erlangen somit die Fähigkeiten, diese später selbständig durchführen zu können. Die erworbenen Fähigkeiten sind Grundlage für laborbasierte Forschungsarbeiten an landwirtschaftlichen Nutztieren im Rahmen von wissenschaftlichen Abschlussarbeiten. Ziel ist zudem die Entwicklung des kreativen, unabhängigen und globalen Denkens zur Lösung komplexer wissenschaftlicher Herausforderungen im Bereich der Reproduktion landwirtschaftlicher Nutztiere.	**Arbeitsaufwand:** Präsenzzeit: 72 Stunden Selbststudium: 108 Stunden
Lehrveranstaltung: Ausgewählte Reproduktionsbiotechnologien (Blockveranstaltung, Übung, Seminar) *Inhalte*: Erstellung von Puffern, Verdünnern und Medien; Kenntnisse zur Vor- und Nachbereitung von Versuchsanstellungen; Legen von Verweilkathetern; Methoden zur Gewinnung von Untersuchungsmaterialien; Erstellung von Karyogrammen; Spermatologische Untersuchungsmethoden (quantitative und qualitative Spermaparameter; Färbemethoden von Spermienzellen); Embryologie am Beispiel des Haushuhns; In-vitro-Fertilisation von Rinderoozyten; Genetische Untersuchungund präimplantative Gendiagnostik sowie genomgestützte Zuchtwertschätzung, Kryokonservierung und Frischkonservierung von Gameten und frühembryonalen Entwicklungsstadien; Endokrinologische Untersuchungen anhand des ELISA-Systems; Gewinnung von Rinderoozyten durch Ovum Pick Up; Dokumentation von Versuchen; Bioinformatik; Recherche wissenschaftlicher Datenbanken; Präsentation der Laborergebnisse; *Literatur:* z.B. Clark & Pazdernik: Biotechnology (Academic Cell Publishing); Pineda & Dooley: Veterinary Endocrinology and Reproduction (Blackwell Publishing); Squires: Applied Animal Endocrinology (CABI); Manual of the International Embryo Transfer Society; Gilbert: Developmental Biology (Sinauer);	6 SWS
Prüfung: (Labor-)Report (max. 10 Seiten, 50%) und mündliche Prüfung (ca. 30 Minuten, 50%) **Prüfungsanforderungen:** Reflexion der Fragestellungen und der Herangehensweisen diese wissenschaftlich zu bearbeiten.	6 C

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**

Bei mehr als 8 Teilnahmeanfragen wird Studierenden mit bestandenem Modul Reproduktionsbiotechnologie (M.Agr.0069) Vorrang eingeräumt	Grundlagen von Fortpflanzung und Leistung beim Nutzsäuger (B.Agr.0331)
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Michael Hölker
Angebotshäufigkeit: jedes Wintersemester; Geblockt 3 Wochen in vorlesungsfreier Zeit vor Beginn Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 8	

Georg-August-Universität Göttingen Module M.Agr.0151: Data Analysis with R in Agricultural Economics	6 C
Learning outcome, core skills: Students learn • the basic functionality of the statistical software package R • how to retrieve, manage and analyze datasets • an independent and autonomous usage of online resources (e.g. packages, support, R-literature) with regard to topics in agricultural economics. The course aims at providing a tool-set for the successful completion of final thesis with quantitative focus.	**Workload:** Attendance time: 55 h Self-study time: 125 h
Course: Data Analysis with R in Agricultural Economics (Block course, Exercise) The course is split into two main components: The first one is mainly concerned with R programming while the second part deals with applied analysis of datasets connected to agricultural economics: **1. Programming in R:** Introduction and basic functionalities, data management, data visualization, coding styles, functions and programming, dynamic report generation and maps **2. Applied Data Analysis:** data sources in agricultural economics and related API packages, application of selected econometric techniques	
Examination: Term Paper (max. 15 pages) **Examination requirements:** Students prove that they are capable of • finding relevant data, manage and manipulate datasets • applying an appropriate econometric or statistical method and create a corresponding code which is comprehensive and reproducible • interpreting data and results through the use of graphical tools. The produced code has to be handed in along with the paper and will also be subject to the evaluation.	6 C

Admission requirements: Econometrics I (*M.WIWI-QMW.004*), Introduction to Econometrics (B.WIWI-VWL.0007) or equivalent	**Recommended previous knowledge:** Basic econometric techniques (OLS)
Language: English	**Person responsible for module:** Prof. Dr. Bernhard Brümmer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 15	

Georg-August-Universität Göttingen **Modul M.Agr.0152: Nachhaltigkeitswissenschaft** *English title: Sustainability Science*	6 C 4 SWS
Lernziele/Kompetenzen: Nach Vollendung des Kurses verfügen die Studierenden über ein Verständnis der theoretischen und empirischen Grundlagen der Nachhaltigkeitswissenschaft. Sie entwickeln die Fähigkeit, komplexe Nachhaltigkeitsfragen zu analysieren und erwerben Problemlösungs-Kompetenzen zur konstruktiven Gestaltung des globalen Umweltwandels.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Nachhaltigkeitswissenschaft (Vorlesung, Seminar) *Inhalte*: Die Nachhaltigkeit der Bewirtschaftung natürlicher Ressourcen hat sich zu einer zentralen Herausforderung der Menschheit im 21. Jahrhundert entwickelt. Die Nachhaltigkeitswissenschaft ist ein rasch wachsendes Forschungsfeld, das die wissenschaftlichen Grundlagen für einen gesellschaftlichen Wandel hin zur Nachhaltigkeit von der lokalen bis zur globalen Ebene bereitstellt. Das Seminar führt in zentrale Theorien und Konzepte der Nachhaltigkeitswissenschaft (Anthropozän, Sozial-ökologische Systeme, Biokulturelle Vielfalt usw.) und beleuchtet die wissenschaftliche und politische Relevanz des Forschungsfelds. Im Mittelpunkt stehen die Probleme, aber auch die Chancen für ein nachhaltiges Landmanagement im Anthropozän.	4 SWS
Prüfung: Schriftliche Hausarbeit (ca. 3000 Wörter, 80%) und Referat (ca. 10 min., 20%) **Prüfungsanforderungen:** Umfangreiche Kenntnisse von Herausforderungen, Konzepten, Diskursen und Lösungsansätzen der Nachhaltigkeitswissenschaft im Kontext der Landnutzung. Anwendung und Transfer dieser Kenntnisse auf ein konkretes Nachhaltigkeitsproblem im Rahmen eines Referats.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Tobias Plieninger
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul M.Agr.0155: Systemanalyse ackerbaulicher Produktionsverfahren** *English title: Analysis Crop Production*	6 C 4 SWS
Lernziele/Kompetenzen: • Erkennen wesentlicher Zusammenhänge der Prozessoptimierung und Systemanalyse (vernetztes Wirken verschiedener Einflussfaktoren) pflanzlicher Produktionsverfahren (Getreide, Raps, Mais, Kartoffeln, Zuckerrübe, Körnerleguminosen) einschließlich der Bedeutung der vor- und nachgelagerten Bereiche und der gesellschaftlichen Ansprüche. • Erkennen komplexer Zusammenhänge im Detail auf Grundlage aktueller wissenschaftlicher Literatur mit Interpretation grafisch/tabellarischer Darstellung und deren statistischer Validierung.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Systemanalyse ackerbaulicher Produktionsverfahren (Vorlesung, Exkursion) *Inhalte*: Vorlesung**:** Für die unterschiedlichen Produktionsverfahren werden systembezogen folgende Teilaspekte betrachtet: genetische Ressourcen/Züchtung/Biotechnologie, Ertragsbildung, Boden/Bodenschutz, Fruchtfolgen/Düngung, Integrierter Pflanzenschutz, Bilanzen/Systemanalyse. Exkursion**:** Ganztagsexkursion im vor- und nachgelagerten Bereich z. B. Züchtung, Verarbeitung und zu einem landwirtschaftlichen Betrieb	4 SWS
Prüfung: Klausur (60 Minuten) **Prüfungsanforderungen:** Vertieftes Verständnis der Multifunktionalität und Zusammenhänge pflanzlicher Produktionsverfahren im Kontext nachhaltiger Produktivitätssteigerung (Effizienz).	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Anne-Katrin Mahlein
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 130	

Georg-August-Universität Göttingen **Module M.Agr.0156: Microfinance for the Rural Poor: A Business Class**	6 C
Learning outcome, core skills: Students learn concepts of different microfinance instruments, such as microcredit, microsaving, and microinsurance. Students can critically evaluate the potentials and drawbacks of microfinance tools for the rural poor. Designing their own business model, students learn how to properly • work in groups • brainstorm an idea • pitch and argue for their business idea • write a business plan	**Workload:** Attendance time: 66 h Self-study time: 114 h
Course: Microfinance for the Rural Poor: A Business Class (Block course, Lecture) *Contents*: This module provides students with an overview of microfinance instruments. In groups, the students will be given case studies involving rural poor from different regions, facing different problems. The challenge is to apply a microfinance instrument to the respective case study, making it a business model. Being supported, the groups will need to create their own business idea, pitch and argue for it and write a business plan to prove it is a thought through idea.	
Examination: Presentation (approx. 20 minutes, 40%) and term paper (max. 12 pages, 60%) **Examination requirements:** Good knowledge about microfinance instruments (definition, criticism, and examples), Applying business ideas in among low-income population (difficulties and chances); Proper writing of a business plan/ argumentation of an idea).	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Oliver Mußhoff
Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul M.Agr.0159: Tierethik** *English title: Animal Ethics*	6 C 4 SWS

Lernziele/Kompetenzen: In Diskussionen um die Nutzung von Tieren, insbesondere in der landwirtschaftlichen Nutztierhaltung, gewinnt die ethische Dimension zunehmend an Bedeutung. In der Veranstaltung werden die Studierenden dazu befähigt, sich mit moralischen Fragen innerhalb der Nutztierhaltung und Nutztierwissenschaft auseinander zu setzen. Dabei sollen sie vornehmlich in Diskussionen moralische Argumentationsweisen erlernen und dadurch eigene Sichtweisen und Urteile begründen können. Darüber hinaus sollen die Studierenden dafür sensibilisiert werden, vielfältige Einstellungen innerhalb der Tierethik nachvollziehen zu können.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Tierethik (Vorlesung, Seminar) *Inhalte*: In einem ersten Teil der Veranstaltung werden Grundlagen, Definitionen und Theorien der Tierethik im Allgemeinen und die spezielle Rolle der landwirtschaftlichen Nutztierhaltung im Besonderen vermittelt. Außerdem sollen moralische Argumentationsweisen über eine aktive Anwendung in Diskussionen erlernt werden. Im Folgenden werden diese ganz konkret anhand aktueller Fragestellungen in der praktischen Nutztierhaltung, gesellschaftlicher Ansprüche sowie in unterschiedlichen Bereichen der Nutztierwissenschaften angewendet. Dabei steht die Frage der ethischen Vertretbarkeit von Praktiken, Methoden und der generellen Nutzung von Tieren im Fokus der Diskussionen. Gegenstand der Diskussionen werden beispielsweise Methoden in der Tierzucht, Tierversuche, herkömmliche Praktiken der Nutztierhaltung oder gesellschaftliche Ansprüche an die Nutztierhaltung sein.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Auseinandersetzung mit bestimmten ethischen Fragestellungen in der Nutztierhaltung und Nutztierwissenschaft unter Anwendung der erlernten moralischen Argumentation.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Vorkenntnisse zur herkömmlichen Nutztierhaltung, Tierzucht und zu Tierversuchen
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. agr. sc. Stefanie Ammer
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen Module M.Agr.0173: Nematology	3 C 2 WLH
Learning outcome, core skills: Basic knowledge of nematode biology, importance as pests; basic methods with regard to their detection, identification and measures of control, use of beneficial nematodes in biological insect control programs; their role in regulation of processes in ecosystems.	**Workload:** Attendance time: 40 h Self-study time: 50 h
Course: Nematology (Praktikum, Seminar) *Contents*: The module deals with the biology of nematodes and their importance in plant protection. The most important taxa of nematodes are presented using permanent slides and living specimen; the most important morphological characters will be identified. Interactions between plant parasitic nematodes, their host plants and antagonistic microorganisms will be discussed. The use of nematodes for innundative biological control will be discussed as well. During the course, students will become familiar with different plant parasitic nematode species and will learn basic techniques for detection and identification. Plant parasitic nematodes will be used to demonstrate effects of different compounds on activity and viability.	
Examination: Written examination (45 minutes) **Examination requirements:** Basic knowledge of morphological characters of nematodes; species identification by DNA-barcoding ability to discriminate between different feeding types of nematodes; biological control of and biological control with nematodes; importance of nematodes for biodiversity	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of molecular diagnostics
Language: English	**Person responsible for module:** Dr. Birger Koopmann
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 12	

Georg-August-Universität Göttingen Module M.Agr.0174: Plant Health Management in Tropical Crops	6 C 4 WLH
Learning outcome, core skills: Students are able to recognize pests and diseases of tropical crops as treated in this course. They critically evaluate scientific and non-scientific publications on crop protection in the tropics. Students are able to create a scientific presentation according to the standards of international conferences and use interactive teaching material; students know the scope and limits of their knowledge in the treated field, they know where to find relevant, reliable information. Students learn to consider subject-related issues from a variety of different perspectives and to work effectively in international teams.	**Workload:** Attendance time: 36 h Self-study time: 144 h
Course: Plant Health Management in Tropical Crops (Lecture, Excursion, Seminar) *Contents*: Blended learning module; presentation of the most important pests and diseases of the most important tropical crop plants: symptoms, life cycles and plant health management (eg. in rice, maize, cacao, coffee, bananas). Additional crops may be included according to students´ preferences and practical experience. Introduction to relevant international data banks and networks. Use of scientific videos on selected topics of crop protection in the tropics.	4 WLH
Examination: Written exam (45 min, 40%), Student presentation with discussion (ca. 20 min presentation + ca. 10 min discussion 60%) **Examination requirements:** • Written exam: main groups of causal agents, basic botany of the crop plants treated, basic biology of causal agents (life cycles etc.), recognition of symptoms, knowledge of control strategies. • Presentation: appropriate according to the standard of international conferences: relevant and sound content, clear structure, style, language (written and spoken) and pronunciation, citation and use of sources according to good scientific practice.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basics of plant pathology, including basics of integrated pest management
Language: English	**Person responsible for module:** Prof. Dr. Michael Georg Rostás
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 2
Maximum number of students: 30	

Additional notes and regulations:

The module is designed as a blended learning-course with strong emphasis on digital material and student based learning. Contact time is reduced to allow thorough preparation of the presentations.

Georg-August-Universität Göttingen **Modul M.Agr.0175: Plant-Herbivore Interactions (Experimental course)** *English title: Plant-Herbivore Interactions (Experimental course)*	3 C 2 SWS
Lernziele/Kompetenzen: Die Studierenden werden die Fähigkeit erlernen, Experimente zu planen, durchzuführen, statistisch auszuwerten, grafisch darzustellen und zu interpretieren. Sie werden in der Lage sein, Sekundärmetaboliten mit Abwehr- oder Signalfunktion aus der Pflanze zu isolieren und zu quantifizieren. Die Studierenden erlernen die Durchführung von Bioassays, welche die Abwehrfunktion der Sekundärmetaboliten nachweisen sollen.	**Arbeitsaufwand:** Präsenzzeit: 40 Stunden Selbststudium: 50 Stunden
Lehrveranstaltung: Plant-Herbivore Interactions (Experimental course) (Übung, Seminar) *Inhalte*: Das Modul ergänzt die gleichnamige Vorlesung und beschäftigt sich mit den Wechselwirkungen zwischen (Nutz)Pflanzen und herbivoren Insekten. Im Praktikum sollen die in der Vorlesung erworbenen Kenntnisse vertieft und Methoden der chemischen Ökologie / Agrarentomologie erlernt werden. Insbesondere werden verschiedene Abwehrstrategien der Pflanze gegenüber Fraßfeinden untersucht. Die Bedeutung von Prädatoren und Parasitoiden für die Populationskontrolle von herbivoren Schädlingen, und somit für den integrierten Pflanzenschutz, werden behandelt. Literatur: Schoonhoven et al. (2005) Insect-Plant Biology, 2nd Ed., Oxford University Press	2 SWS
Prüfung: Protokoll über die durchgeführten Experimente (max. 15 Seiten) **Prüfungsanforderungen:** Dokumentation und Interpretation der durchgeführten Versuche entsprechend dem wissenschaftlichen Standard. Seminarvortrag	3 C

Zugangsvoraussetzungen: An „M.Agr.0058.Mp: Plant-Herbivore Interactions" erfolgreich teilgenommen.	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Michael Georg Rostás
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Woche
Wiederholbarkeit: einmalig	**Empfohlenes Fachsemester:** ab 2
Maximale Studierendenzahl: 12	

Georg-August-Universität Göttingen **Module M.Agr.0180: Mineral Nutrition of Crops Under Different Climate and Environmental Conditions**	6 C 4 WLH
Learning outcome, core skills: Students acquire knowledge of characteristic properties and specialities of nutrient cycles of ecosystems of different climate zones and upon different environmental drivers. Participants develop understanding of important processes and interactions between abiotic condition of locations, processes in soils and in particular on their effects on plant nutrient uptake. They know plant adaptation mechanisms. Students also get knowledge of the use of stable isotopes for the study of the above processes.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Mineral nutrition of crops under different climate and environmental conditions (Lecture) *Contents*: Lectures focus on element dynamics in ecosystems starting with element inputs, their internal turnover processes and dynamics and outputs. In the course of the semester they will cover sub-arctic over temperate to tropical zones and key examples. In each zone a key focus will be on adaptation mechanisms that can be found among wild plants and crops. About one third of the module will address stable isotope methods for studying such subjects.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Knowledge of key characters of nutrient cycles in different climate zones with respect to major problems of soil fertility, plant nutrient supply and other environmental impacts, including anthropogenic management. Second important focus on adaptation mechanisms in plants to cope with nutritional constraints. Basic knowledge in stable isotope tracer methods and natural stable isotope abundance methods for the study of above research subjects.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basics in plant physiology, chemistry and soil science
Language: English	**Person responsible for module:** Prof. Dr. Klaus Dittert
Course frequency: each winter semester	**Duration:**
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 36	

Additional notes and regulations: After successful conclusion of M.Agr.0103 students can not complete M.Agr.0180

Georg-August-Universität Göttingen Module M.Agr.0181: Biochemical Processes in the Rhizosphere	3 C 2 WLH

Learning outcome, core skills: The course is aimed to extend a basic knowledge on general features and peculiarities of the rhizosphere in natural and agroecosystems to the specific rhizosphere processes and components; rhizosphere interactions with soil, other plants, animals, microorganisms; fluxes of elements; effect of Global Change on rhizosphere processes and mitigation strategies. The course focuses on facilitation of the student's interests to ecological studies and on motivation of the students for creative application of knowledge on environmental processes to understand, explain and predict rhizosphere processes.	**Workload:** Attendance time: 30 h Self-study time: 60 h

Course: Biochemical Processes in the Rhizosphere (Lecture, Seminar) *Contents*: **The Rhizosphere: introduction, definitions and seminar topics overview** • C-balance between leaves and root; Root hairs; Nutrient mobilization in the rhizosphere; Rhizodeposition & Global Change; Mycorrhiza. **Microbial ecology in the rhizosphere** • Definitions and scales of interactions • Rhizosphere gradients • The rhizosphere microbial community • Principles of Microbial Ecology in the rhizosphere **Rhizodeposits and root exudates** • Substrate sources in the Rhizosphere • Interactions in the rhizosphere induced by rhizodeposition: positive – negative direct and indirect interactions **Application of modern ecological concepts to the rhizosphere study** • A home-field advantage • Microbial loop • Food webs • Active and dormant microorganisms • Hotspots and hot moments **Plant-mediated nutrient acquisition from SOM** • Rhizosphere priming effect • Role of complexation & chelation reactions in nutrients mobilization in the rhizosphere • Metal bridges concept • Organic N uptake by Plant **The rhizosphere under global change** • Effects of elevated CO2on below ground processes • Role of mucilage in extreme drought mitigation	2 WLH

• Rhizosphere microbial community under fluctuating freezing-thawing **Visualization of the rhizosphere processes** • Planar optodes • Laser scanning & X-ray microtomography • 2D and 3D zymography • Link the process localization with their rates: kinetic approaches in the rhizosphere	
Examination: Written Exam (60 minutes, 70%), Seminar Talk (approx. 15 min., 30%)	3 C

Admission requirements: Basic soil science and biochemistry knowledge	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** [kein Vorname] N.N.
Course frequency: each winter semester	**Duration:**
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 24	

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Agr.0182: Blended E-course: Crop Modelling for Risk Management</td><td>6 C
4 WLH</td></tr>
</table>

<table>
<tr><td>Learning outcome, core skills:
• To gain understanding of the theory underlying the simulation of major crop growth and development processes
• To get familiarized with the technical features of a concrete model, APSIM, and learn setting up model runs through distinct deepening exercises
• To apply gained theoretical and technical knowledge to independently perform crop simulation experiments on distinct risk management strategies

Overall goal of this blended E-learning course will be for students to get familiarized with the basic theory underlying major process descriptions in crop simulation modelling, the features & options to run a specific model, APSIM; learn apply & evaluate APSIM to a self-chosen case of risk management in crop cultivation</td><td>Workload:
Attendance time:
56 h
Self-study time:
124 h</td></tr>
</table>

<table>
<tr><td>Course: Blended E-course: Crop Modelling for Risk Management
Contents:
Crop Modelling for Risk Management (blended E-Course)

In the first part of the lectures, students will learn about theory and concepts of modelling different major ecophysiolgical processes such as photosynthesis of a crop canopy, water dynamics and nitrogen uptake. Exercises will be demonstrated and performed in self-studies on how to simulate process outcomes for given biophysical conditions. In part two, guided online exercises will be provided to set up different simulations (e.g. intercropping, climate change effects etc.) using the APSIM model. Finally, students will work on selected case studies addressing typical systems agronomic questions (how to optimize nutrient management, closing yield gaps, identifying suitable rotations for given environments).

The module consists of self-learning lectures and exercises, interjected with (at least) three physical meetings to check on and discuss progress.</td><td></td></tr>
<tr><td>Examination: Oral report (approx. 20 minutes, 50%) with written elaboration (max 10 pages, 50%)
Examination requirements:
Good understanding of the model APSIM and its underlying theory (process) descriptions and of input- and output variables and technical model features for simulating genotype x environment x management interactions in potential, water-limited and nitrogen-limited production situations; Understanding of model evaluation methods.</td><td>6 C</td></tr>
</table>

<table>
<tr><td>Admission requirements:
Working through distinct video lectures and associated exercises via ILIAS platform ; and participation in the physical meetings of this blended e-learning course.</td><td>Recommended previous knowledge:
Basics in agronomy, soil science & plant nutrition, plant physiology, agrometeorology</td></tr>
<tr><td>Language:</td><td>Person responsible for module:</td></tr>
</table>

English	Prof. Dr. Reimund Paul Rötter
Course frequency: each winter semester	**Duration:**
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 16	

Additional notes and regulations:

This course is made available as a blended e-learning module through the University of Goettingen's e-learning platform ILIAS, using a combination of innovative teaching methods, such as interactive online Joint Classrooms, online exercises and physical meetings for presenting and discussing specific case study modelling setups and modelling results.

Exams: Both together*, (i) oral presentation of the chosen simulation experiment with discussion, and (ii) written documentation of the crop model simulations, will show whether learning goals on theory and its application to practical problems have been achieved.

Georg-August-Universität Göttingen **Module M.Agr.0186: Multivariate Statistics with Applications in Agricultural Sciences**	6 C 4 WLH
Learning outcome, core skills: The students will get a comprehensive overview of multivariate statistics from both a theoretical and applied perspective. This module aims to teach fundamental skill on how to approach analysis of univariate and multivariate datasets and how to interpret results. Practical applications will partially be performed in the software R.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Multivariate statistics with applications in agricultural sciences (Lecture) *Contents*: • Multivariate regression • Multivariate random variables • Multivariate testing • Principal components analysis • Factor analysis • Cluster analysis • Multidimensional scaling • MANOVA • Neural Networks	4 WLH
Examination: Written examination (90 minutes) **Examination prerequisites:** Working on 50% of the exercises and presentation of the solution of at least one exercise, as well as active participation in the exercises.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic courses in math or statistics. Examples for this could be M.Agr.0036 (Methodisches Arbeiten: Versuchsplanung und –auswertung), M.Agr.0076 (Statistische Nutztiergenetik), M.iPAB.0015 (Applied Machine Learning in Agriculture in R).
Language: English	**Person responsible for module:** N. N.
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul M.Agr.0188: Isotopes in Ecosystem Science** *English title: Isotopes in Ecosystem Science*	6 C 2 SWS
Lernziele/Kompetenzen: The course is aimed to deepen the competence in the use of isotopes to study ecosystem processes. It aims at familiarizing the participants with a broad set of isotope applications, from fractionation based natural abundance approaches up to tracer applications. Advantages and disadvantages of stabile and radionuclides will be discussed and the set of instrumentation required for their measurement shall be understood.	**Arbeitsaufwand:** Präsenzzeit: 30 Stunden Selbststudium: 150 Stunden
Lehrveranstaltung: Isotopes in Ecosystem Science (Vorlesung) *Inhalte*: Introduction, stable and radioactive isotopes Labeling and natural abundance, Tracer approaches Quantifying of stable and radioactive isotopes (Isotope ratio mass spectrometry, gas lasers, scintillation counting, autoradiography and phosphorimaging, gamma-detectors, accelerated mass spectrometers, etc Applications of isotopes in soil – plant – ecosystem studies • C, N and P input by plants into the soil 14C,13C,15N,33P • C turnover and soil organic matter studies 14C,13C • Nutrient cycles in soils 15N,33P,32P • Visualization of belowground processes 14C,33P,32P • Isotope dilution method 15N • Bomb-14C: a global labeling approach 14C • Use of isotopes for erosion quantification 137Cs • Coupling of isotopes with molecular biology and biomarkers • Metabolic tracing based on position- and dual isotope labeling approaches	2 SWS
Prüfung: Mündlich Mündlich (ca. 30 Minuten) (ca. 30 Minuten) **Prüfungsanforderungen:** Profound understanding of Isotope methods and their application. Ability to assess toolset of isotope methods required for the investigation of a defined research question in ecosystem sciences. Technical understanding of the principles underlying the instrumentation for isotope measurement.	6 C

Zugangsvoraussetzungen: none	**Empfohlene Vorkenntnisse:** Basic soil science and chemistry knowledge
Sprache: Englisch	**Modulverantwortliche[r]:** Jun.-Prof. Dr. Michaela Anna Dippold
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

24	

Georg-August-Universität Göttingen **Modul M.Agr.0189: Digitales Marketing im Agribusiness** *English title: Digital Marketing in Agribusiness*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden lernen die Grundlagen und Werkzeuge des Online Marketings sowie Arbeitsweisen im digitalen Umfeld kennen. Dazu gehört zu verstehen, wie digitale Märkte funktionieren (ökonomische Charakteristika), welche Kanäle es gibt und wie diese anzuwenden sind. Darüber hinaus wird vermittelt, mit welchen Methoden Kunden im Netz identifiziert und adressiert werden können. Weitere Lernziele sind die Bedeutung von digitialem Mindset, digital Leadership und wie sich die Wertschöpfungsketten von off- und online-Produkten verändert.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Digitales Marketing im Agribusiness (Vorlesung, Seminar) *Inhalte*: Es werden die Instrumente des Online Marketing-Mixes (Kommunikations-, Preis-, Produkt- und Distributionspolitik) im digitalen Kontext beleuchtet und mit Beispielen aus dem Agribusiness sowie anderen Branchen veranschaulicht. Es folgt ein Überblick über Werkzeuge und Methoden zur Marktforschung und Kundengewinnung. In diesem Zusammenhang werden rechtliche Rahmenbedingungen in Bezug auf Datensicherheit behandelt. Zudem werden neue digitale Tools wie AI, IoT oder VR vorgestellt. Abschließend erfolgt eine Auseinandersetzung mit digitalem Kommunikations- und Prozessmanagement sowie mit digitalen Geschäftsmodellen im Agribusiness.	
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsvorleistungen:** Teilnahme an einem Blockseminar, wobei erfolgreich eine Kurzpräsentation (ca. 6 Minuten) mit anschließender Diskussion abgehalten wird. **Prüfungsanforderungen:** Kenntnisse zum Online Marketing bestehend aus Besonderheiten der Online Kommunikations-, Preis-, Produkt- und Distributionspolitik, Methodenkenntnissen und konkrete Anwendungsfällen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Achim Spiller Dr. Winnie Sonntag
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul M.Agr.0190: Raus aufs Land - Forschungsmodul Soziologie Ländlicher Räume** *English title: Off to countryside – Research Module Rural Sociology*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden sollen lernen, wie land- und agrarsoziologische Fragestellungen methodisch umzusetzen sind. Dazu werden verschiedene Methoden empirischer Sozialforschung reflektiert und diskutiert. Ziel ist es, methodische Fragen an konkreten Forschungsprojekten der Beteiligten zu bearbeiten. Die qualitativen und quantitativen Forschungsprojekte können auch die Forschungsarbeiten zur Abschlussarbeit darstellen. Die Studierenden lernen verschiedenste empirische Methoden kennen und sollen durch die Teilnahme am Modul zu selbstständigem wissenschaftlichen Forschen und Arbeiten angeleitet und bei der Umsetzung unterstützt werden.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Raus aufs Land - Forschungsmodul Soziologie Ländlicher Räume (Seminar) *Inhalte*: Landwirtschaft, ländlicher Raum, ländliche Lebensverhältnisse stehen wieder verstärkt im Fokus wissenschaftlichen, öffentlichen, aber auch politischen Interesses. Mit welchen empirischen Methoden nähere ich mich welcher landsoziologischen Fragestellung? Das Einsatzfeld qualitativer und quantitativer Methoden reicht von Einzelinterviews, über teilnehmende Beobachtung bis hin zur Gemeindestudie. Wo finde ich meine Proband*innen, wie wähle ich sie aus? Welche Methoden bieten sich zur Analyse qualitativer Daten an, welche für quantitative? In diesem Forschungsseminar werden sehr konkret land- und agrarsoziologische Fragestellungen mit Fragen der empirischen Sozialforschung verknüpft. Es wird an Fallbeispielen der beteiligten Studierenden gearbeitet. Referat: In einem 20-minutigen Referat werden die Ergebnisse der (eigenen) Felduntersuchungen präsentiert und kritisch diskutiert. Dies beinhaltet neben einer kurzen Einleitung, die Darstellung der Methodik, statistische bzw. qualitative Datenauswertung und eine Diskussion der Ergebnisse unter Einbeziehung von Sekundärliteratur, wie z.B. wissenschaftlichen Fachpublikationen. Hausarbeit: In Form eines Forschungstagebuchs (Umfang max. 10 Seiten) werden das Forschungsprojekt und dessen Ergebnisse kritisch reflektiert. Zusätzlich können Vorträge von weiteren Wissenschaftler*innen der Georg-August-Universität oder anderer Hochschulen und Institutionen zu spezifischen sowie methodischen Inhalten im Rahmen des Seminars stattfinden.	4 SWS
Prüfung: Präsentation der eigenen Forschung (ca. 20 Minuten und ca. 15 Minuten Diskussion, 50 %) und Vorlage eines Forschungstagebuchs (max. 10 Seiten, 50 %) **Prüfungsvorleistungen:** Teilnahme an den Sitzungen sowie Durchführung eines eigenen Forschungsprojekts (kann im Rahmen einer Abschlussarbeit, Promotion oder Drittmittelprojektes erfolgen).	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Claudia Neu
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0191: Nährstoffdynamik in der Rhizosphäre** *English title: Nutrient Dynamics in the Rhizosphere*	3 C 2 SWS
Lernziele/Kompetenzen: Nutzung von mathematischen Modellen und Ergebnisinterpretation zur Bearbeitung wissenschaftlicher Themen. Die Studierenden erlernen eine wissenschaftliche Fragestellung im Versuch zu bearbeiten und die Ergebnisse im wissenschaftlichen Vortrag vorzustellen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Nährstoffdynamik in der Rhizosphäre (Vorlesung, Übung) *Inhalte*: Das Modul besteht aus einem Vorlesungs- und Übungsteil Vorlesung: Modellierung des Nährstofftransportes im Boden und der Aufnahme, Sensitivitätsanalyse der Modellparameter. Interne und externe Faktoren des Wurzelwachstums, Wurzelmorphologie und Wurzelverteilung im Boden. Chemische Veränderung der Rhizosphäre, Mikrobiologie der Rhizosphäre, Stickstoffbindung, Mykorrhiza. Übung: Die Studierenden führen einen Versuch zur Modulthematik durch (Anlage, Durchführung, Messung, Auswertung) und stellen die Ergebnisse in Form eines Seminarbeitrages vor.	2 SWS
Prüfung: Klausur (90 Minuten, 60%) und Präsentation (ca. 20 Minuten, 40%) **Prüfungsvorleistungen:** Teilnahme an den Übungen **Prüfungsanforderungen:** Kenntnis der grundlegenden chemischen und mikrobiellen Prozesse in der Rhizosphäre und ihrer Bedeutung für die Nährstoffaufnahme. Beherrschen der methodischen Ansätze zu ihrer Charakterisierung und Modellierung.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Klaus Dittert
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 24	

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.Agr.0193: Model Approaches and Applications in Agro-ecosystems</td><td>3 C</td></tr>
<tr><td>Learning outcome, core skills:
Students learn fundamentals of the mathematical description of processes and the solution of systems of equations. They are introduced to model approaches for different relevant processes in agro-ecosystems and can assess their strengths and weaknesses. They learn to consider interactions of physical, biological and chemical processes by coupling processes in more complex models and the practical handling of different models and their sensitivity. They learn about possible applications for practical questions in the agricultural and environmental sector including possibilities and problems of model regionalization.</td><td>Workload:
Attendance time:
64 h
Self-study time:
26 h</td></tr>
<tr><td>Course: Model approaches and applications in agro-ecosystems (Lecture, Exercise)
Contents:
Course, Part I: Fundamentals of process-oriented soil-plant modelling
Different types of models from the field of soil processes, plant growth processes and pest models covering basic processes and their mathematical formulation
Possibilities of model calibration and validation based on measurement data
Exercises with simple models on soil heat, water and matter transport
Model approaches to plant growth in crop rotations
Simple models for pathogens and disease infestation in arable crops
Course, Part II: Modelling process interactions in agroecosystems
Modelling interactions between water, matter balance and plant growth (water and nutrient-limited production levels)
Mechanisms for quantifying the yield and quality losses in plant production due to biotic stress factors (pathogens and diseases) will be presented (reduced level of production)
more complex models for the interaction of water and material balance, plant growth and pest infestation to be presented and used for problem-oriented questions
The practical use of models for the agricultural sector is demonstrated in exercises
Regionalization and uncertainties of models</td><td></td></tr>
<tr><td>Examination: Written examination (45 minutes)
Examination prerequisites:
Working on 50% of the exercises and presentation of the solution of at least one exercise, as well as active participation in the exercises
Examination requirements:
Basic knowledge of processes and related model characteristics, interactions of processes, awareness on sources of model uncertainty, data requirements for model building and testing, basics on regionalization and scaling, skills in applying models to answer practical questions in agro-environmental research.</td><td>3 C</td></tr>
</table>

Admission requirements: none	**Recommended previous knowledge:** Basics in crop and soil science, phytopathology
Language: English	**Person responsible for module:** Prof. Dr. Dr. Kurt Christian Kersebaum
Course frequency: each winter semester; 2 x one full week's block Course, Part I: begin WS; Part II: end WS	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 15	

Georg-August-Universität Göttingen **Modul M.Agr.0194: Naturschutz interfakultativ I** *English title: Nature Conservation I (interfaculty lectures)*	3 C 2 SWS

Lernziele/Kompetenzen: Die Studierenden sollen sich durch die interfakultative Naturschutzausbildung ein breites Wissen im Bereich Naturschutz aneignen und die Beiträge aus Agrarwissenschaften, Biologie, Forstwissenschaften und Geographie zu einem Gesamtbild zusammenführen. Dazu gehört die inhaltliche Integration unterschiedlicher Methoden und Ansätze und die kritische Bewertung des Beitrags verschiedener Disziplinen zu aktuellen Problemen des Globalen Wandels.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Naturschutz interfakultativ 1 (Vorlesung, Seminar) *Inhalte*: Im Rahmen einer interfakultativen Naturschutzausbildung für die vier "grünen" Falkultäten (Agrar, Bio, Forst, Geo) werden insgesamt zwei Module (Naturschutz interfakultativ I und II) angeboten. In diesem ersten Block geht es um die wissenschaftlichen Grundlagen des biologischen Naturschutzes (Abteilung Naturschutzbiologie, ein Block aus M.Biodiv. 412), die Grundlagen der Agrarökologie (Abt. Funktionelle Agrobiodiversität, Block 2 der Veranstaltung B.Agr.0001) und die "Landscape-ecological theory" (Geographisches Institut, in englischer Sprache). Die Studierenden belegen jeweils vier ausgewählte Termine (Blöcke) in den Veranstaltungen (4 Sitzungen á 90 min).	
Prüfung: Klausur (60 Minuten) **Prüfungsanforderungen:** Klausur (60 Minuten zu allen drei Themenblöcken Naturschutzbiologie, Agrarökologie und Landschaftsökologie). Erarbeitung des in den Vorlesungen angebotenen Wissens.	3 C

Zugangsvoraussetzungen: Die Teilnahme am Modul ist nur möglich, wenn das Modul B.Agr.0001: Agrarökologie und Umweltpolitik nicht bereits im BSc Studium belegt wurde.	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Catrin Westphal
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen **Modul M.Agr.0196: Projektseminar: Regionale Zukunftsszenarien einer nachhaltigen Landwirtschaft** *English title: Project Seminar: Regional Future Scenarios of Sustainable Agriculture*	6 C 4 SWS

Lernziele/Kompetenzen: • Verständnis und Erproben der Methode der partizipativen Szenarienentwicklung • Kenntnis von Kernkonzepten wie "landscape sustainability science", "Scenarios", "Visions", "Drivers of change", "Narratives" und "Backcasting" • Fähigkeit, Veränderungsprozesse in Agrarlandschaften systematisch aus einer sozial-ökologischen Perspektive zu analysieren • Kennenlernen von Formaten des Wissenschafts-Politik-Praxis-Dialogs • Erwerb bzw. Training von Präsentations- und Kommunikationsfähigkeiten in Gruppenarbeiten	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Projektseminar: Regionale Zukunftsszenarien einer nachhaltigen Landwirtschaft (Vorlesung, Seminar) *Inhalte*: Agrarlandschaften sind einem rapiden sozialen und ökologischen Wandel ausgesetzt (u.a. durch Klimawandel, sich ändernde gesellschaftliche Rahmenbedingungen und technische Fortschritte). Partizipative Szenario-Techniken können helfen, diesen Wandel zu verstehen und aktiv zu gestalten. Das Projektseminar diskutiert gegenwärtige Triebkräfte des Agrarlandschaftswandels und die vielfältigen (und miteinander konfligierenden) gesellschaftlichen Werte von Agrarlandschaften. In Kleingruppen werden die Studierenden mit allen Arbeitsschritten der Szenario-Entwicklung vertraut gemacht und wenden diese Technik auf eine örtliche Agrarlandschaft und deren Akteur*innen an. Dabei spielt die Beurteilung von Innovationen für eine nachhaltige Landnutzung eine wichtige Rolle. Das Modul bietet die Gelegenheit, Techniken der partizipativen Szenario-Planung zu erlernen und zu erproben. Sutherland, L.-A. et al. (2015): Transition pathways towards sustainability in agriculture. Case studies from Europe. CABI. Weitere Literaturhinweise werden während des Kurses zur Verfügung gestellt.	4 SWS
Prüfung: Gruppenberichte (max. 20 p.) (70%) und Gruppenpräsentationen (30 min.) (30%)	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Tobias Plieninger
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**

Georg-August-Universität Göttingen Module M.Agr.0197: Sustainability – Basics and Application	6 C
Learning outcome, core skills: In this course, students will learn about the fundamental concepts and ideas that underpin sustainability on a global level. It aims at creating a deeper understanding of the fair use of resources and its challenges on local and global scale. Sustainable development is not only a difficult practical challenge but also a conceptual, political and moral problem. How can an understanding of the complexities help to shape approaches to solutions? Students will acquire discursive and reflective competencies. Students will work with local stakeholders and acquire practical insights for implementing sustainability in real-life applications.	**Workload:** Attendance time: 66 h Self-study time: 114 h
Course: Sustainability – basics and application (Internship, Lecture, Seminar,) **Course: *Part 1 Sustainability basics*** (Lectures and self-study) The first module part introduces students to sustainability concepts (environmental, social and economic), and sustainable development (SDGs). Building on these foundations, the main part of the module is practical. ***Part 2 Sustainability application*** (seminar, practical work and self-study) Students can choose one topic and work on a sustainability-related task in either interdisciplinary teams or local companies, NGOs and university projects. What is a particular sustainability challenge? What measures can help to realize sustainability goals and what trade-offs hinder the success of implementation. A seminar will be organized to present, discuss and reflect the practical work.	
Examination: oral presentation in the seminar (ca. 10min, 30%) and written report for practical part 2 (max. 10 pages, 70%) **Examination prerequisites:** Seminar attendance	6 C

Admission requirements: open for all faculties	**Recommended previous knowledge:** none
Language: English, German	**Person responsible for module:** Dr. Simone Pfeiffer (CBL, Centre of Biodiversity and Sustainable Land Use) Dr. Michaela Dölle (Faculty of Forest Sciences and Forest Ecology)
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 35	

Georg-August-Universität Göttingen **Module M.Agr.0198: Scientific Working in Agricultural and Agribusiness Economics**	6 C 4 WLH

Learning outcome, core skills: After successful completion of the module, students will be able to describe the structure of scientific manuscripts and apply it to their own texts. They recognize the functionality and structure of the common sections of scientific manuscripts and can evaluate the form of scientific manuscripts. They can derive relevant research questions from the literature and generate related empirically testable hypotheses. They can select appropriate methods and databases to test these hypotheses. They can communicate their research approach in the form of an extended abstract. Students can give and receive constructive feedback and incorporate received feedback into their texts.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Scientific Working in Agricultural and Agribusiness Economics (Lecture, Exercise) *Contents*: The first part of the module covers the basics of organizing the research process with a focus on systematic literature search and evaluation, as well as the formulation of research questions and related empirically testable hypotheses. The second part covers the writing of scientific manuscripts with a focus on the structure and content of the typical sections. Students practice applying the content and techniques to given topics in working groups. This includes practical applications of systematic literature search, writing short texts (abstracts and extended abstracts), and discussing and evaluating other people's texts according to the criteria learned.	4 WLH
Examination: Extended abstract (max. 1200 words) **Examination prerequisites:** Submission of assignments: literature search strategy, written abstract, peer feedback Participation in peer feedback discussions (up to 4 sessions) **Examination requirements:** Knowledge of how to • structure a scientific manuscript, • integrate a research question into the existing literature • present and interpret results according to standards in agricultural and agribusiness economics • derive appropriate conclusions and relate them to the respective research body and research goal	6 C

Admission requirements: none	**Recommended previous knowledge:** Introduction to Econometrics (Modul B.WIWI-VWL.0007) or equivalent
Language: English	**Person responsible for module:** Dr. Stefan Seifert
Course frequency: each summer semester	**Duration:** 1 semester[s]

Number of repeat examinations permitted: twice	**Recommended semester:** 2 - 3
Maximum number of students: 24	

Georg-August-Universität Göttingen **Modul M.Agr.0199: Planung und Auswertung experimenteller Master-Arbeit in Nutzpflanzenwissenschaften** *English title: Planning and evaluation of experimental Master thesis in crop sciences*	3 C 1 SWS
Lernziele/Kompetenzen: Eigenständige Planung und Auswertung von Versuchen im Bereich der Nutzpflanzenwissenschaften	**Arbeitsaufwand:** Präsenzzeit: 14 Stunden Selbststudium: 76 Stunden
Lehrveranstaltung: Planung und Auswertung experimenteller Master-Arbeit in Nutzpflanzenwissenschaften *Inhalte*: Die Studierenden erarbeiten unter Anleitung des Modulverantwortlichen anhand der geplanten Master-Abschlussarbeit konkrete Versuchspläne (mit Excel möglich) und auf deren Grundlage die entsprechenden Datenstrukturen und die sich daraus ergebenden Auswertemethoden. Nach der Versuchsdurchführung werden die Versuchsergebnisse unter Anleitung mit SAS oder R statistisch ausgewertet, die Auswertestrategie und --schritte ausführlich im SAS- oder R-Skript kommentiert, begründet und die Ergebnisse graphisch und tabellarisch präsentiert. Das Angebot richtet sich an Studierende der Fachrichtung Nutzpflanzenwissenschaften sowohl im Bachelor- als auch im Master-Studium, jedoch können Credits nur einmal im Bachelor **oder** Master durch die Prüfungsleistung erworben werden. In Abgrenzung zum entsprechenden Angebot im Bachelor-Studium sind Überlegungen zur Fallzahlplanung und/oder post hoc Poweranalyse durchzuführen. Unter Umständen kann sich das Modul auch auf in Praktika erhobene Daten beziehen und gewählt werden (siehe Zugangsvoraussetzungen). (Generell besteht für Studierende der Fachrichtung Nutzpflanzenwissenschaften das Angebot, sich bei Fragen der Versuchsplanung und -auswertung an Dr. Christian Kluth zu wenden). *Angebotshäufigkeit:* Nach Bedarf, Terminvergabe durch Modulverantwortlichen	3 SWS
Prüfung: Hausarbeit **Prüfungsanforderungen:** Versuchsbeschreibung, strukturierte und klar beschriebene Daten und Randomisationsplan, lauffähiges, kommentiertes R- oder SAS-Skript, in dem die Auswertestrategie ausführlich beschrieben und begründet wird. Die Ergebnisbeschreibung, wie sie in der Masterarbeit dargestellt wird, ist nicht Teil der Bewertung, vielmehr mögliche alternative Darstellungsformen mit der entsprechenden Begründung der Darstellungsweise.	3 C

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**

Vor Versuchsdurchführung muss die mögliche Anerkennung der Prüfungsleistung mit dem Modulverantwortlichen und der/dem BetreuerIn abgesprochen werden. Eine Anerkennung der Prüfungsleistung kann ohne vorherige Absprache der Versuchsplanung nur in Ausnahmefällen erfolgen.	Grundlagen in einer statistischen Programmiersprache (R oder SAS), Modul Versuchsplanung und Auswertung
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Dr. Christian Kluth
Angebotshäufigkeit: Nach Bedarf, Terminvergabe durch Modulverantwortlichen	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 3 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: Zur Auswertung der Abschlussarbeit empfohlen.

Georg-August-Universität Göttingen **Module M.Agr.0200: Machine Learning in Food Economics and Agribusiness**	6 C 4 WLH
Learning outcome, core skills: Machine learning is changing the world from different dimensions, and agricultural and food economics is no exception. In contrast to econometrics of causal analysis, machine learning put more emphasis on prediction and pattern recognition. This course will briefly introduce machine learning algorithms for research of agricultural and food economics. It will help master students to master bask techniques in programing for machine learning with Python and their application in food economics and agribusiness analysis.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Machine Learning in Food Economics and Agribusiness (Lecture, Exercise) *Contents*: This course will introduce basic algorithms in machine learning and apply them to research of agribusiness and food economics. Specifically, we will introduce Python language, and how to use Python to realize plotting, feature engineering, linear regression, logit model, support vector machine, k-nearest neighbor, random forest, k-means clustering, neural network and deep learning (ANN, CNN and RNN). **Course Outline** 1. Introduction to Python and its application of machine learning in agricultural economics 2. Data Plotting and visualization 3. Linear regression and feature engineering 4. Logit model and support vector machine 5. k-nearest neighbor and discrimination analysis 6. Classification and random forest 7. Artificial neural network and deep learning (CNN and RNN) 8. Unsupervised learning: k-means clustering, PAM, Principal Component Analysis, and 9. Machine learning with time series data **Programming Requirement**: 1. Python : https://www.python.org/ 2. Anaconda: https://www.anaconda.com/ 3. VScode: https://code.visualstudio.com/ **Text books:** Swamynathan Manohar.2017.Mastering Machine Learning with Python in Six Steps. APress. Matthes E. , 2022. Python Crash Course, 3rd Edition. No Starch Press, L.A. Raschka Sebastian, Yuxi (Hayden) Liu, Vahid Mirjalili.2022. Machine Learning with PyTorch and Scikit-Learn. Packet Press. 2022.	4 WLH

Reference Papers : Wang H. , X. Yu (2023) “Carbon Dioxide Emission Typology and Policy Implications: Evidence from Machine Learning”. Forthcoming in China Economic Review. Maruejols L., L. Hoeschle, X. Yu (2022) Vietnam between economic growth and ethnic divergence: A LASSO examination of income-mediated energy consumption. Energy Economics. Graskemper V., X. Yu and Jan-Henning Feil (2022) Values of Farmers-Evidence from Germany, Journal of Rural Studies. Vo. 89:13-24. Wang H., L. Maruejols, and X.Yu (2021) Predicting energy poverty with combinations of remote-sensing and socioeconomic survey data in India: Evidence from machine learning. Energy Economics. Vol. 102, 105510. https://doi.org/10.1016/j.eneco.2021.105510 Graskemper V., X. Yu and Jan-Henning Feil (2021). Farmer Typology and Implications for Policy Design – an Unsupervised Machine Learning Approach. Land Use Policy. Volume 103, April 2021, 105328.	
Examination: Written examination (120 minutes, 70%) and homework assignments (30%) **Examination requirements:** Examination requirements: 1. Understand the machine learning models taught in the class 2. Use python skillfully	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Xiaohua Yu
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: not limited	

Georg-August-Universität Göttingen Module M.Agr.0201: Dynamic modelling in land use systems	6 C 4 WLH

Learning outcome, core skills: System dynamics is an interdisciplinary field of study that combines insights from various disciplines, such as sociology, agronomy, economics, ecology and computer science, to understand the behaviour of complex systems over time. The course on system dynamics aims to equip students with a solid understanding of the principles and methods used in this field. The targets of the course include developing an understanding of complex systems, teaching students how to model and simulate these systems, analysing feedback loops, understanding system behaviour, optimizing systems, and developing effective communication skills.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Dynamic modelling in land use systems (Lecture, Exercise) *Contents*: System dynamics is an interdisciplinary field of study that combines insights from various disciplines, such as sociology, agronomy, economics, ecology and computer science, to understand the behaviour of complex systems over time. The course on system dynamics aims to equip students with a solid understanding of the principles and methods used in this field. 1. Understanding complex systems: The primary target of a course on system dynamics is to help students develop an understanding of complex systems. System dynamics is concerned with the study of systems that are made up of interdependent components that interact with one another in complex ways. These systems can be found in a wide range of fields, such as economics, ecology, healthcare, and engineering. A course on system dynamics provides students with the necessary tools and techniques to analyse and model such systems, and to understand the behaviour of these systems over time. 2. Modelling and simulation: Another important target is to teach students how to develop models of complex systems and simulate their behaviour. System dynamics modelling involves constructing a graphical representation of the system, identifying the key components and their interrelationships, and developing equations that describe the behaviour of the system over time. Simulation involves running these equations to generate predictions of how the system will behave under different conditions. A course on system dynamics helps students develop the skills needed to create and run such models and simulations, and to interpret the results. 3. Analysis of feedback loops: Feedback loops are a central concept in system dynamics, and a course on this topic aims to help students understand their role in complex systems. Feedback loops occur when the output of a system is fed back into the system as input, leading to a cycle of cause and effect. System dynamics courses teach students how to identify different types of feedback loops, such as reinforcing and balancing loops, and how they can impact the behaviour of a system. Students also learn how to analyse the dynamics of feedback loops using mathematical and computational tools.	4 WLH

4. Understanding system behaviour: A course on system dynamics also helps students understand the behaviour of complex systems over time. System dynamics models can be used to generate predictions of how a system will behave under different conditions, and to identify key factors that influence the behaviour of the system. Students learn how to use these models to understand the behaviour of systems in various domains, such as business, healthcare, and the environment. They also learn how to interpret the results of these models and to use them to make informed decisions. 5. System optimization: In addition to understanding system behaviour, a course on system dynamics also teaches students how to optimize complex systems. System optimization involves identifying the goals of the system and developing strategies to achieve them while taking into account various constraints and trade-offs. Students learn how to use system dynamics models to optimize systems in various domains, such as supply chain management, energy systems, and transportation. 6. Communication: Finally, a course on system dynamics aims to develop students' communication skills. Students learn how to communicate complex concepts and models to a wide range of audiences, including policymakers, managers, and other stakeholders. Effective communication is critical in system dynamics, as it helps to ensure that the insights generated by models are understood and acted upon by decision-makers. The targets of the course include developing an understanding of complex systems, teaching students how to model and simulate these systems, analysing feedback loops, understanding system behaviour, optimizing systems, and developing effective communication skills.	
Examination: 4 Home assignments (50%), 1 written paper (50%) **Examination prerequisites:** attendance of 80% of the course sessions	6 C

Admission requirements: none	**Recommended previous knowledge:** Regional Economics, Agroecology, Agr. Sociology, div
Language: English, German	**Person responsible for module:** Dr. sc. agr. Holger Bergmann
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:**
Maximum number of students: 16	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.Agr.0202: Digitale Technologien in der Pflanzenproduktion - technische Grundlagen
English title: Digital Technologies in Plant Production - Technical Basics</td><td>6 C
4 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Die Studierenden vertiefen ihre Kenntnisse auf dem Gebiet der technischen Grundlagen digitaler Technologien und deren Nutzung in Pflanzenproduktionssystemen.
Sie kennen die ausgewählten Verfahren und Anwendungen zugrunde liegenden Technologien und können Bezüge zu den Aufgaben in der Pflanzenproduktion herstellen.

Der Schwerpunkt der Lehrveranstaltung liegt auf den Anwendungsbereichen Precision Agriculture / Smart Farming sowie der Nutzung digitaler Technologien in der Agrartechnik.</td><td>Arbeitsaufwand:
Präsenzzeit:
56 Stunden
Selbststudium:
124 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Digitale Technologien in der Pflanzenproduktion - technische Grundlagen (Vorlesung, Übung)
Inhalte:
Im Rahmen der Lehrveranstaltung erlernen die Studierenden vertiefte technische Kenntnisse zu digitalen Technologien im Pflanzenbau. Die Veranstaltung geht dabei von ausgewählten Sensoren und den zugrunde liegenden Messprinzipien über technische Systeme in Landmaschinen bis zu ausgewählten Anwendungsbeispielen.
Eingangs werden Auswahl und Anwendung von Sensoren thematisiert und grundlegende Messprinzipien vermittelt. Bei den technischen (Teil-)Systemen von Maschinen werden z.B. ISOBUS, GNSS, Spurführung und Bediensysteme behandelt. Die Integration in Maschinen und die technische Umsetzung ausgewählter Funktionen wird an verschiedenen Landmaschinen vertieft.
Das Thema Datenerfassung wird des Weiteren im Bereich der UAV-Nutzung vermittelt.
In einem weiteren Bereich wird die Datenanalyse und -nutzung an Beispielen behandelt. Hier werden ausgewählte Datensätze bearbeitet und z.B. Applikations- oder Ertragskarten abgeleitet.
An einem Laboraufbau werden Grundzüge der Automatisierung vermittelt und praktisch erprobt.
In der Übung werden u.a. folgende Inhalte behandelt:
• Ausgewählte Beispiele für den Einsatz von Sensoren zur Erfassung von Pflanzenzuständen, Anwendung von N-Sensoren.
• Ausgewählte Beispiele für den Einsatz von Sensoren zur Erfassung von Maschinenparametern / -zuständen.
• Anwendung verschiedener Sensorprinzipien im Laboraufbau.
• Drohnenbefliegungen: Grundlagen, Missionsplanung, Befliegung.
• Auswertung von ausgewählten Datensätzen.
• Ableitung von Applikationskarten.</td><td>4 SWS</td></tr>
</table>

• Grundlagen und Nutzung von GNSS- und Spurführungssystemen. • Bediensysteme von Landmaschinen (ausgewählte Beispiele). • ISOBUS für Landmaschinen. • Einplatinenrechner-Programmierung. • Automatisierung am Beispiel FarmBot.	
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** 2 bestandene Laborleistungen (unbenotet) **Prüfungsanforderungen:** Vertiefte Kenntnisse auf dem Gebiet der digitalen Technologien in Pflanzenproduktionssystemen, deren Funktionsweise und Einsatz in verschiedenen Bereichen der Pflanzenproduktion und in Landmaschinen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Frank Beneke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 24	

Georg-August-Universität Göttingen Module M.Agr.0203: Livestock and Biodiversity in Agricultural Landscapes	3 C 2 WLH
Learning outcome, core skills: About two thirds of the agriculturally utilized area in Central Europe is managed for livestock farming. The historical development of the agriculturally used landscape has been strongly influenced by livestock husbandry already since the Neolithic age. Similarly, the modern agricultural landscape, its appearance, biodiversity and ecological function can hardly be fully explained without considering livestock husbandry. The module has four learning objectives: (i) to become familiar with and apply scientific methodology to analyze processes of how livestock management affects biodiversity and ecological functions, (ii) to learn fundamental relationships between the type and intensity of livestock management, the behavioral preferences of livestock, particularly at pasture, i.e. while grazing, (iii) to learn about the history of landscape development under the influence of livestock farming, (iv) to learn, identify and develop livestock management practices that aim to conserve and enhance biodiversity and landscape management as a whole.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Livestock and Biodiversity in Agricultural Landscapes (Lecture, Exercise) *Contents*: Overview of the development of agricultural landscapes in Central Europe and the role of grazing animals. Influence of grazing animals on processes of vegetation development at landscape scale, opening of forest, proportion of open land, vegetation structures at landscape scale. Role of behavioral traits and preferences of grazing animals in processes controlling vegetation development. Role of production systems in vegetation development. Fundamentals of grazing management to control vegetation development. Use of grazing animals in landscape management, objectives, opportunities, practical implementation. Basic contents are taught in the lecture, which accounts for about two-thirds of the attendance hours. In a practice-oriented exercise, case studies with data from research and practice are used to analyze systems of livestock farming with regard to the consequences for vegetation, biodiversity, landscape management. This Investigation will be performed as a group task.	2 WLH
Examination: oral (weight: 80 %, duration: 15 minutes) and group work/exercise (weight: 20 %, short presentation, one-page thesis paper) **Examination requirements:** Knowledge of the module contents from lecture and exercise.	3 C

Admission requirements:	**Recommended previous knowledge:**
none	Basic knowledge of livestock production, agroecology,

	botany, crop production.
Language: German, English	**Person responsible for module:** Prof. Dr. Johannes Isselstein Dr. Martin Komainda
Course frequency: each winter semester1	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Modul M.Agr.0205: Hot Topics in der Agrarsoziologie – kritische Auseinandersetzung mit aktueller land- und agrarsoziologischer Forschung** *English title: Hot Topics in Rural Sociology - a critical examination of current research*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden sollen lernen, wie land- und agrarsoziologische Fragestellungen in der Wissenschaft methodisch bearbeitet und theoretisiert werden. Sie werden mit verschiedenen Themenbereichen der agrarsoziologischen Forschung vertraut gemacht, wie z.B. gesellschaftliche Kritik an der Landwirtschaft, Lebens- und Arbeitssituation von Landwirt*innen, Geschlechterverhältnisse, Protestbewegungen etc. Dazu werden verschiedene aktuelle und kontroverse wissenschaftliche Veröffentlichungen der Land- und Agrarsoziologie von den Studierenden kritisch analysiert, reflektiert und diskutiert. Ziel dieses Kurses ist es, die Masterstudierenden an die kritische Reflexion und Diskussion aktueller wissenschaftlicher Positionen in der Land- und Agrarsoziologie heranzuführen. Hierzu vertiefen sie ihre Fertigkeiten im Lesen und Verstehen von wissenschaftlichen Artikeln. Dabei sollen den Studierenden wissenschaftliche Herangehensweise, Methodenwahl und struktureller Aufbau von land- und agrarsoziologischen Veröffentlichungen vermittelt werden. Darüber hinaus werden sie mit der wissenschaftlichen Diskussionskultur vertraut gemacht.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Hot Topics in der Agrarsoziologie – kritische Auseinandersetzung mit aktueller land- und agrarsoziologischer Forschung (Seminar) *Inhalte*: Bauernproteste, ungleiche Geschlechterverhältnisse, Höfesterben - dies sind nur drei „hot topics“ mit denen sich die (aktuelle) Land- und Agrarsoziologie befasst. Sie erforscht die Aspekte sozialen Zusammenlebens in ländlichen Gesellschaften und der Landwirtschaft. Mit welchen empirischen Methoden werden land- und agrarsoziologische Fragestellungen bearbeitet? Welche aktuellen Diskurse umfassen land- und agrarsoziologische Veröffentlichungen und welchen Aufbau weisen sie auf? In diesem Kurs erhalten Masterstudierende einen Überblick über aktuelle Themen der ländlichen Soziologie und Agrarsoziologie sowie über methodische Herangehensweisen zur Bearbeitung relevanter Forschungsfragen. Zu diesem Zweck werden ausgewählte Artikel aus internationalen Fachzeitschriften gelesen, vorgestellt und kritisch diskutiert, sowohl im Hinblick auf inhaltliche als auch auf methodische Aspekte. Die Artikel, die im Kurs behandelt werden, umfassen	4 SWS

z.B. folgende Themengebiete: Transformationsprozesse in der 4 SWS Landwirtschaft, soziologische Aspekte bäuerlicher und unternehmerischer Landwirtschaft, Geschlechterforschung in der Landwirtschaft, postkoloniale Kritik in der Landwirtschaft, Hofnachfolge, Existenzgründung, landwirtschaftliche Familienbetriebe, Protestbewegungen in der Landwirtschaft. Zusätzlich können Vorträge von weiteren Wissenschaftler*innen der Georg-August-Universität oder anderer Hochschulen und Institutionen zu spezifischen Inhalten sowie methodischen Herangehensweisen im Rahmen des Seminars stattfinden. Referat: In einem 20-minütigen Referat wird eine ausgewählte Fachpublikation präsentiert und kritisch diskutiert. Dies beinhaltet neben- einer kurzen Einleitung, die Darstellung der Methodik, statistische bzw. qualitative Datenauswertung und eine kritische Diskussion der Ergebnisse unter Einbeziehung von anderen wissenschaftlichen Fachpublikationen. Hausarbeit: Verfassen eines Essays zu einem selbstgewählten land- oder agrarsoziologischem Thema oder Anfertigung einer Buch- oder Artikelrezension.	
Prüfung: Präsentation, Referat oder Korreferat (ca. 15 Minuten, 40% Gewichtung) und Hausarbeit (max. 10 Seiten, 60% Gewichtung) **Prüfungsanforderungen:** Konstruktive Beteiligung an der Diskussion in den Vorlesungen, was die Lektüre der angegebenen Artikel voraussetzt. In den Prüfungen sollen die Studierenden demonstrieren, dass sie Forschungsfragen, Methode und Ergebnisse in den behandelten Themengebieten kritisch hinterfragen und diskutieren können.	6 C

Prüfungsanforderungen: ECTS-Bedingungen de	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Janna Luisa Pieper
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul M.Agr.0207: Ökonomische Aspekte des Klimawandels in Agrar-und Ernährungssystemen** *English title: The Economics of Climate Change in Agri-food Systems*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erlernen grundlegende Konzepte der Ökonomik des Klimawandels mit Fokus auf Agrar- und Ernährungssysteme. Der Kurs diskutiert die Konsequenzen des Klimawandels auf Agrar- und Ernährungssysteme mit einem Schwerpunkt auf verhaltensökonomische Ansätze, um die Herausforderungen, die Klimawandel mit sich bringt, besser erklären zu können. Einen weiteren Schwerpunkt bilden Politikmaßnahmen, um Klimaschutz voranzutreiben. Hier werden unter anderem CO2 Steuern und der mögliche Handel mit CO2 Zertifikaten in der Landwirtschaft, sowie technische Möglichkeiten zum landwirtschaftlichen Klimaschutz besprochen. Als letzter Teil des Kurses werden die Auswirkungen von Ernährungsumstellungen und globaler Nachfrage nach Lebensmitteln sowie die Verlagerung des Problems (Treibhausgas Emissionen) durch Regulierung behandelt.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Ökonomische Aspekte des Klimawandels in Agrar-und Ernährungssystemen (Vorlesung, Übung, Seminar) *Inhalte*: Dieses Modul besteht aus einer Kombination aus Vorlesung und Übungen, wobei die theoretischen Konzepte aus der Vorlesung mit Anwendungsbeispielen aus Wissenschaft und Praxis ergänzt werden. In den letzten Semesterwochen halten die Studierenden zu ausgewählten Themen einen Vortrag. Dies dient dazu, dass die Studierenden erlernte Inhalte und Probleme gezielt selbstständig vertiefen und bewerten können. Die Vorlesung wird durch Diskussionen von aktuellen Beispielen aus den Medien ergänzt. • Grundlegende Konzepte und Wissenschaft des Klimawandels • Agrar- und Ernährungssysteme in einem sich verändernden Klima • Klimawandel und öffentliche Güter aus Sicht der Verhaltensökonomie • Politikinstrumente für Klimaschutz • Globale Nachfrage nach Lebensmitteln, Agrarhandel und Klimaschutz	4 SWS
Prüfung: Klausur (60 Minuten, 70%) und Präsentation (ca. 20 Minuten, 30%)	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Doris Läpple
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

25	

Georg-August-Universität Göttingen **Module M.Agr.0208: Soil Biogeochemistry of Agricultural and Forest Ecosystems- Lecture, Seminar and Lab course**	6 C 4 WLH
Learning outcome, core skills: • Understanding C, N, P, S and Fe cycle in agro-and forest ecosystems • Understanding the impact of land management on these element cycles • Quantification of C-, N-and P-fluxes via isotope-based methods (labeling experiments such as pulse labeling, FACE experiments, C-3 and C-4 vegetation changes, autoradiography • Formation of soil organic matter from plant and microbial residues: Disentangling and characterizing the composition of SOM Theoretical basics shall be thought and their application shall be demonstrated at distinct examples from literature. After this course, students will be able to understand complex biogeochemical studies published and evaluate potentials and pitfalls of applied methods.	**Workload:** Attendance time: 73 h Self-study time: 107 h
Course: Soil Biogeochemistry of Agricultural and Forest Ecosystems- Lecture, Seminar and Lab course (Lecture, Practical course, Seminar) *Contents*: In the framework of this module, biogeochemical processes of C, N, P, S and Fe cycle in agro- and forest ecosystems shall be demonstrated and their microbial and molecular basics will be unraveled. It will be shown how land use, forest and agricultural management practices (crop sequences, tillage, fertilization, etc.) will impact the element cycles. Analytical biogeochemical methods to assess these effects on element fluxes and cycles will be explained in detail. Isotope-based examples and experiments to assess formation and turnover of soil organic matters as will be explained. The module consists of a lecture (2 SWS) and a seminar (1 SWS) in which a methodological focus will be set where one study of interest will be presented by the students, and training study will be implemented. The lab course part consists of one week intensive lab course followed by a short period of data evaluation, or as five weeks with one full day per week in the lab/practical work at the end of the lecturing period (depending on laboratory capacity).	4 WLH
Examination: Oral examination (approx.20 minutes, 75%), presentation (approx. 15 minutes, 25%) **Examination requirements:** Understanding of biogeochemical cycles in agroecosystems and their drivers as well as the impact of agricultural management on them. Ability to choose, evaluate and discuss about various biogeochemical, molecular and microbiological methods to study element cycles and their drivers in soils.	
Examination requirements: ECTS-Bedingungen de	

Admission requirements:	**Recommended previous knowledge:**

none	Basics in soil science, biology, physics and chemistry
Language: English	**Person responsible for module:** UnivProf.Dr. Martin Maier
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.Cp.0007: Pesticides II: Toxicology, Ecotoxicology, Environmental Metabolism, Regulation and Registration**	6 C 4 WLH
Learning outcome, core skills: Students will understand the basic and applied pesticide toxicology and ecotoxicology, the development of pesticides and risk assessment, and the regularory framework of pesticide registration and pesticide risks (Germany, EU)	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Pesticides II: Toxicology, Ecotoxicology, Environmental Metabolism, Regulation and Registration (Lecture) *Contents*: This unique module gives an overview of all aspects of pesticide science, presented by Several lecturers, being specialists. Basic and applied toxicology of pesticides , ecotoxicology of pesticides, environmental fate and metabolism of compounds in different environments, development of pesticides, regulation of pesticide use and registration.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Knowledge of the toxicology of pesticides, ecotoxicology, fate and metabolism in the environment, regulation and registration of pesticides in Germany and the EU.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Andreas von Tiedemann
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 3
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul M.Cp.0008: Fungal Toxins** *English title: Fungal toxins*	6 C 4 SWS

Lernziele/Kompetenzen: Die Teilnehmer werden für die Bedeutung von Sekundärmetaboliten von Pilzen in der Pflanzenproduktion sensibilisiert. Sie werden in die Lage versetzt, eine vergleichende Bewertung der Relevanz von natürlichen Toxinen und anthropogenen Stoffen durchzuführen und die verschiedener Lebensmittelkontaminanten toxikologisch einzuordnen. Im Laborteil werden sie praktische Kenntnisse von chemisch-analytischen Verfahren erwerben, die es ihnen ermöglichen, für konkrete Aufgaben in ihrem Beruf die optimale analytische Methode zu wählen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Fungal Toxins (Vorlesung, Laborpraktikum) *Inhalte*: Es werden die für die Praxis wichtigsten Mykotoxine vorgestellt, Konzepte der Toxizitätsbestimmung erläutert, Verfahren für die Ableitung von gesetzlichen Limits erklärt und das von den Mykotoxinen ausgehende Risiko für die Gesundheit von Verbrauchern und Nutztieren bewertet. Die ökologischen Funktionen von Mykotoxinen werden diskutiert, Methoden für die Mykotoxinbestimmung erklärt und Verfahren zur Reduktion der Mykotoxinbelastung bei Pflanzenprodukten erläutert. Ausgewählte Phytotoxine und Phytohormone werden vorgestellt, die als Virulenz- oder Pathogenitätsfaktoren an der Ätiologie von Pflanzenkrankheiten beteiligt sind. Im praktischen Teil werden die Modulteilnehmer die Aufbereitung von Pflanzenmaterial durchführen und ausgewählte Methoden für die Mykotoxinbestimmung anwenden.	4 SWS
Prüfung: Klausur (60 Minuten) **Prüfungsvorleistungen:** Voraussetzung ist angenommenes Protokoll vom Praktikum **Prüfungsanforderungen:** Die wichtigsten Mykotoxine in der Pflanzenproduktion; Methoden der Toxizitätsbestimmung, Ableitung von gesetzlichen Limits; ökologische Funktionen von Mykotoxinen; Methoden für die Mykotoxinbestimmung; Einflussgrößen auf die Mykotoxinbelastung von Pflanzenprodukten; die Rolle von Phytotoxinen und Phytohormonen als Virulenz- und Pathogenitätsfaktoren.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. M. Alhussein
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

12	

Georg-August-Universität Göttingen Module M.Cp.0014: Plant Nutrition and Plant Health	3 C 2 WLH
Learning outcome, core skills: Knowledge of and ability to present the presented topics in their context: development of nutritional and processing quality in different crop plants; quality requirements and ways of realization by crop production methods.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Plant Nutrition and Plant Health (Lecture, Seminar) *Contents*: Nutrient uptake and transport in the plant; function of different nutrients in the plant especially with respect to plant health (susceptibility, tolerance, resistance); mechanisms to increase the efficiency of nutrient availability, uptake and use; characteristics of plant health, effect of nutrient imbalances on plant metabolism and development of plant harvest products, the nutrient concentrations and processing quality.	2 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Understanding the relationship between plant nutrition and plant health and its significance in the value-added food chain.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Klaus Dittert
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.Cp.0025: Analytical Techniques for Foods and Agricultural Research**	6 C 4 WLH

Learning outcome, core skills: This module aims to provide students with a comprehensive understanding of chemical analysis techniques employed in agricultural research through a combination of practical experiments and lectures, which will cover the analysis of major chemical groups in plants, fungi, and pesticide residues.	**Workload:** Attendance time: 70 h Self-study time: 110 h

Course: Analytical Techniques for Foods and Agricultural Research (Lecture, Practical course) *Contents*: The module will include various topics related to chemical analysis methods in agricultural sciences. The analysis of plant primary and secondary metabolites (such as carbohydrates, amino acids, organic acids, phytohormones, phytoalexins, glucosinolates, and volatiles) will be discussed. Moreover, the analysis of mycotoxins, fungal secondary metabolites, and pesticide residues will be covered. The module will introduce the fundamental analytical chemistry methods, including sample preparation, separation techniques, detection methods, characterization, and quantification of metabolites using state-of-the-art chromatographic and mass spectrometric methods.	4 WLH
Examination: oral exam (30 min, 70%), Student presentation with discussion (ca. 20 min presentation + ca. 10 min discussion, 30%)	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Mohammad Alhussein
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 16	

Georg-August-Universität Göttingen **Module M.FES.122: Ecological Simulation Modelling**	6 C 4 WLH

Learning outcome, core skills: • Knowledge of the modelling techniques covered; • Ability to find a suitable modeling technique for a given problem in the area of ecology and to apply it independently; • Knowledge of the current state of research in ecological modelling; • Critical appreciation and discussion of research results; • Refined presentation techniques; • Knowledge of constructive feedback techniques.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Simulation Modelling (Lecture, Exercise)	3 WLH
Course: Current Topics in Ecological Modelling (Seminar)	1 WLH
Examination: Presentation (approx. 15 min) with written outline (max. 10 pages) **Examination prerequisites:** Presentation (approx. 15 Minutes), ungraded	6 C

Examination requirements: • Know, explain, apply, analyse and assess model types that are applied in ecology • Know, explain, apply, analyse and assess the stages of model development along the modeling cycle • Present, explain and critically reflect a self developed simulation model • Understand and summarize published model studies and point out and discuss their possibilities and limitations	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Kerstin Wiegand
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:**
Maximum number of students: 20	

Additional notes and regulations: 20 students are only possible if a corresponding number of computers is available. Module is also applicable for other study programs, such as MSc "Biological Diversity and Ecology", MSc "Agriculture" (specialization Ressourcenmanagement).

Georg-August-Universität Göttingen **Module M.FES.720: Agent-Based Modelling with NetLogo**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
• Comprehensive knowledge of agent-based modelling for beginners; • Ability to select, conceptualize, apply, implement, and document agent-based modelling techniques in NetLogo with respect to a given question (with a focus on ecological questions); • Development of an own agent-based modelling project; • Development of interdisciplinary analytical thinking; • Critical analysis and evaluation of the potentials and limitations of agent-based models based on the scientific literature; • Refined presentation skills	Attendance time: 56 h Self-study time: 124 h

Course: Agent-based modelling with NetLogo (Block course, Exercise, Seminar) *Contents*: Computer course: Modelling with NetLogo Seminar: Modelling paper classics (including ungraded student presentations on classical modelling papers)	4 WLH
Examination: Oral Presentation (approx. 20 minutes)	6 C

Examination requirements:	
Comprehensive knowledge of agent-based modelling techniques. Ability to select, conceptualize, apply, implement, and document agent-based modelling techniques in NetLogo with respect to a given question. Skills to develop a modelling project. Interdisciplinary analytical skills. Ability to critically analyze and evaluate potentials and limitations of published agent-based models. Presentation skills	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Katrin Mareike Meyer
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Modul M.Forst.221: Fernerkundung und GIS** *English title: Remote Sensing and GIS*	6 C 4 SWS
Lernziele/Kompetenzen: Ziel der Veranstaltungen dieses Moduls ist es, den Studierenden einen umfassenden Einblick in die wesentlichen Arbeitsabläufe der fernerkundlichen digitalen Bildverarbeitung und -analyse zu geben. Die Veranstaltung ist in die aufeinander abgestimmten Teilmodule "Geografische Informationssysteme" und „Fernerkundung“ gegliedert. Beide Teile ermöglichen eine Erweiterung der im Bachelorstudium erworbenen, grundlegenden Kenntnisse. In praxisorientierten Kleinprojekten sollen die Studierenden Grundkenntnisse der Vektor- und Rasterdatenverarbeitung in Theorie und praktischer Anwendung kennenlernen und in einem GIS umsetzen. Die Studierenden sollen sich nach den Lehrveranstaltungen auf Basis der erworbenen Grundkenntnisse selbstständig spezielle Verarbeitungsfunktionen erschließen können und sollen auch die Möglichkeiten der Automatisierung von Geodaten-Verarbeitungsprozessen kennen. Die Lehrveranstaltungen versetzen die Studierenden in die Lage, selbstständig Projekte auf raumbezogener Datenbasis, ausgehend von der fernerkundlichen Informationsextraktion aus digitalen Bilddaten bis zur Analyse der generierten Geoobjekte, zu bearbeiten. Die Studierenden sollen befähigt werden, analytisch raumbezogene Fragestellungen zu lösen, Arbeitsprozesse zu strukturieren und zu gestalten sowie dafür im Team zu arbeiten und kooperativ zu agieren. Die in Vorlesungen und Übungen vermittelten Kenntnisse orientieren sich an den aktuellen Anforderungen raumbezogener interdisziplinärer Forschungsprojekte.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Geografische Informationssysteme (Vorlesung, Übung) *Inhalte*: Einführung in QGIS (Kennenlernen der Benutzungsoberfläche, Geodatenformate und -quellen, Hinzufügen von Layern), Umgang mit Vektorattributdaten, Vektordatengenerierung, Vektor- und Rasterdatenverarbeitung, Grundlagen zu Koordinatenbezugssystemen, Symbologie-Optionen für Vektor- und Rasterdaten, Erstellung von Drucklayouts.	2 SWS
Prüfung: Klausur (60 Minuten)	3 C
Lehrveranstaltung: Fernerkundung (Vorlesung, Übung) *Inhalte*: Grundlagen Rasterdaten, Prinzipien der digitalen Bildverarbeitung, Evaluation der Bildqualität auf Basis von Bildstatistiken, Prinzipien der Bildverbesserung, Vorstellung aktueller Sensoren und Plattformen zur Erdbeobachtung, Verwendung von überwachten Klassifikationsverfahren und maschinellen Lernen (ML) zur Erstellung thematischer Karten, Genauigkeitsanalyse thematischer Karte, Analyse von Drohnenbildern, multi-temporale Bildanalyse.	2 SWS
Prüfung: Klausur (60 Minuten)	3 C
Prüfungsanforderungen: **Geografische Informationssysteme:**	

Kenntnis der Benutzungsoberfläche von QGIS und wichtiger QGIS-Funktionalitäten wie Projektanlage und -weitergabe, Umgang mit Geodatenformaten und -quellen, Umgang mit Koordinatenbezugssystemen, Symbologie-Optionen für Vektor- und Rasterdaten, Erstellung von Kartenlayouts. Fähigkeit zur Lösung raumbezogener Problemstellung unter Einsatz von Vektor- und Rasterdatenverarbeitungsfunktionen. **Fernerkundung:** • Grundlagen elektromagnetischer Strahlung und deren Interaktion mit der Atmosphäre und mit Landbedeckungsformen, • Grundlegende Techniken der Fernerkundungsbildvorbereitung, -bearbeitung, -verbesserung und -klassifikation, wie in den Übungen behandelt, • Anwendung der Software, die in den Übungen verwendet wird, • Beurteilung der Qualität von Fernerkundungs-Bildprodukten, einschließlich Genauigkeitsanalyse.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Erforderlich sind Kenntnisse in der Kartografie, der Fernerkundung, deskriptiven Statistik und einfachen Stichprobenstatistik sowie GIS-Grundkenntnisse (entsprechend den üblichen Lehrveranstaltungen in Bachelorstudiengängen).
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Winfried Kurth
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul M.Forst.754: Böden der Welt: Verbreitung, Eigenschaften und Nutzung** *English title: Soils of the Earth: Distribution, Characteristics and Use*	6 C 4 SWS

Lernziele/Kompetenzen: Vertiefende Kenntnisse über die Geologie, Geomorphologie und Bodenbildung, Bodeneigenschaften und Bodennutzung der Wichtigsten Ökozonen der Erde. Lösung praktische Landnutzungsprobleme die typisch für die Bodennutzung in den unterschiedliche Ökozonen sind und oft mit biogeochemische Kreisläufe zusammenhängen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Böden der Welt: Verbreitung, Eigenschaften und Nutzung (Vorlesung, Übung) *Inhalte*: Die Veranstaltung vermittelt theoretische und praktische Kenntnisse über die Geologie, Geomorphologie und Bodenbildung, Bodeneigenschaften und Bodennutzung der Wichtigste Ökozonen der Erde: Polare und subpolare Zone (Tundra); Boreale Zone (Taiga); Feuchte Mittelbreiten (gemäßigte Zone); Trockene Mittelbreiten (Steppengebiete); Winterfeuchte Subtropen (Mediterrangebiete); Trockene Tropen und Subtropen (Wüstengebiete); Sommerfeuchte Tropen (Savannengebiete); immerfeuchte Subtropen (Ostseitengebiete); immerfeuchte Tropen (Regenwaldgebiete) und Gebirgsregionen. Im Seminar werden Probleme vorgetragen die typisch für die Bodennutzung/Biogeochemische Kreisläufe in den unterschiedliche Ökozonen.	4 SWS
Prüfung: Referat (ca. 10 Minuten) mit schriftl. Ausarbeitung (max. 10 Seiten) und mündliche Prüfung (ca. 15 Minuten)	6 C

Prüfungsanforderungen: Präsentation eines Referats zu einem ausgewählten Thema aus dem Bereich Bodenkunde; vertiefte Kenntnisse über die Verbreitung, Genese, Eigenschaften und Nutzung der Böden Weltweit.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Edzo Veldkamp
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul M.Forst.756: Bodenhydrologische Übung** *English title: Practice in Soil Hydrology*	9 C 6 SWS

Lernziele/Kompetenzen: Es sollen die Grundlagen der Wasserspeicherung und des Wassertransportes in Böden vermittelt werden. Dabei wird der Schwerpunkt auf Messprinzipien der bodenphysikalischen Kenngrößen in Feld- und Laborsituationen gelegt. Die Studierenden sollen in Kleingruppen Versuche zur Bestimmung des Wasserpotentiales, des Wassergehalts, der pF-Kurven, der hydraulischen Leitfähigkeit unter gesättigten und ungesättigten Bedingungen und des Transportverhaltens gelöster Stoffe durchführen. Lernziele sind: • Erlernen und Anwendung grundlegender bodenphysikalischer Messmethoden • Erfassung bodenhydrologischer Kenngrößen sowie • Bewertung der Ergebnisse im ökologischen Zusammenhang	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Bodenhydrologische Übung (Vorlesung, Übung)	6 SWS
Prüfung: Protokolle (max. 50 Seiten)	9 C

Prüfungsanforderungen: Vertiefte Kenntnisse der bodenhydrologischen Charakterisierung von Böden und Verständnis bodenphysikalischer Zusammenhänge. Methodische Fertigkeiten im Bereich bodenhydrologischer Analytik. Bewertung und Interpretation von Messergebnissen.	

Zugangsvoraussetzungen: Grundlegende Kenntnisse in Bodenkunde	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Martin Jansen
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 12	

Georg-August-Universität Göttingen **Modul M.Forst.757: Bodenmikrobiologische Übung** *English title: Practice in Soil Microbiology*	9 C 6 SWS
Lernziele/Kompetenzen: Anwendung bodenmikrobiologischer Methoden. Berechnung und statistische Auswertung bodenmikrobiologischer Parameter und Prozessraten. Bewertung der Ergebnisse in einem holistisch-ökosystemaren Zusammenhang.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden
Lehrveranstaltung: Bodenmikrobiologische Übung (Übung) *Inhalte*: Die TeilnehmerInnen werden in der Anwendung verschiedener bodenmikrobiologischer Methoden angeleitet, die der Erhebung ökosystem-relevanter Parameter und Prozessraten dienen. Vor dem Hintergrund globaler Umweltveränderungen soll der Einfluss verschiedenster Umweltfaktoren (z.B. Landnutzung, Temperatur, Nährstoffverfügbarkeit) auf die bodenmikrobiologischen Parameter und Prozessraten untersucht und ausgewertet werden. Dabei lernen die TeilnehmerInnen mikrobielle Stoffwechselprozesse kennen und mikrobielle Stoffwechselprodukte sowohl in der Gas- als auch Flüssigphase zu detektieren und zu quantifizieren. Mithilfe statistischer Methoden, die eine Analyse und Bewertung sowohl molekularer als auch öksystemarer Prozesse und deren Interaktion erlauben, werten die TeilnehmerInnen die selbstständig erhobenen Daten aus, präsentieren die Ergebnisse graphisch und interpretieren sie in einem holistisch-ökosystemaren Kontext. Außerdem erlenen die TeilnehmerInnen, wissenschaftliche Originalliteratur auf dem Gebiet der Bodenmikrobiologie zu verstehen und Ihren Inhalt schriftlich zusammen zu fassen.	6 SWS
Prüfung: Protokoll (max. 15 Seiten)	9 C
Prüfungsanforderungen: Wissen mikrobieller Stoffwechselprozesse und Kenntnisse verschiedener bodenmikrobiologischer Methoden und deren Anwendung, um Auswirkungen mikrobieller Stoffwechselprozesse auf molekularer Ebene auf ökosystemare Stoffflüsse im Boden-Pflanze-Atmosphäre Kontinuum untersuchen zu können. Recherche und kritische Auseinandersetzung mit wissenschaftlich-bodenmikrobiologischer Fachliteratur und deren Präsentation.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Marife Corre
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**

Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen Module M.Geg.08a (IMSOGLO): Field course on human-environment interactions	6 C 7 WLH
Learning outcome, core skills: The students have an integrative perspective on human-environment systems in various landscapes of central and southern Europe, which they explore during the field course. They understand the interlinkages “Geology/Geomorphology - Climate/Paleoclimate - Vegetation - Soils - Development of adapted human land-use systems - potential effects of Global Change” for these landscapes. This concept is extended to landscapes in different parts of the world, as each IMSOGLO student introduces a landscape of his/her home country to the group according to the above scheme of interlinkages in the evenings of the field course. The participants reflect on the diverse human-environment systems and share their perspectives with the international excursion group. These evening discussions raise the awareness that each perspective is influenced by a certain sociocultural background, and that different perspectives may be equally appreciated. Thus, they lead to a more global and self-reflexive perspective of the participants.	**Workload:** Attendance time: 98 h Self-study time: 82 h
Course: Field course (14 days) (Course)	7 WLH
Examination: DIN A 0 poster, to be presented during the field course (approx. 15 min.) **Examination prerequisites:** Regular participation in field course.	6 C
Examination requirements: The students proof that they understand and are able to explain present the following interlinkages in their landscape: “Geology/Geomorphology - Climate/Paleoclimate - Vegetation - Soils - Development of adapted human land-use systems - potential effects of Global Change” for a landscape in their home country.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: German, English	**Person responsible for module:** Prof. Dr. Daniela Sauer
Course frequency: Every second year in March	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Geg.17: Landscape Ecology**	6 C 4 WLH
Learning outcome, core skills: The students know the components of element, water and energy budgets and fluxes in landscapes, and the most important element cycles. They are familiar with assessing soil properties and soil distribution patterns in landscapes, and with the measurement of microclimatic parameters. The students are able to generate hypotheses on the mutual relationships relief-soils-microclimate, to develop appropriate strategies for testing their hypotheses and to apply them in practice. The students have the competency to work on a research question in small international, culturally diverse teams, in a creative and outcome-oriented way. Thereby, they appreciate diverse cultural backgrounds and different approaches to handle a task. They are able to reflect on these in a constructive way and to jointly develop strategies for solving their research questions.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Landscape-ecological methods (Lecture)	1 WLH
Course: Landscape-ecological theory (Lecture)	1 WLH
Course: Landscape-ecological project (Seminar) with project-type components to be carried out in small international teams including measurements in the field.	2 WLH
Examination: Presentation (ca. 30 Min.) with written report (max. 20 p.) or DIN A 0 poster **Examination prerequisites:** Regular attendance of the seminar and active involvement in the field measurements	6 C
Examination requirements: The students proof that they are able to generate hypotheses on the mutual relationships relief-soils-microclimate, to develop appropriate strategies for testing their hypotheses, considering different perspectives, and to apply them in practice. They proof that they can collaborate in an international team, interpret, document, present, discuss their results, and critically reflect the applied methods and obtained outcomes.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Daniela Sauer
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 1
Maximum number of students:	

20	

Additional notes and regulations:
The students get a confirmation letter about successful participation in an international module held in English language.

Georg-August-Universität Göttingen **Modul M.Pferd.0004: Ernährungsphysiologie und Fütterung des Pferdes** *English title: Nutrition Physiology and Feeding of the Horse*	6 C 4 SWS

Lernziele/Kompetenzen: Ausgehend von der Vermittlung ernährungsphysiologischer Zusammenhänge wird die Urteilsfähigkeit gegenüber allen wichtigen Fragen der aktuellen Pferdefütterung vermittelt. Durch Einbeziehung wichtiger Forschungsfragen werden zugleich die Fähigkeit zur gezielten Auseinandersetzung mit hergebrachten Ansichten in der Pferdeernährung und die selbständige Wissensaneignung befördert.	**Arbeitsaufwand:** Präsenzzeit: 62 Stunden Selbststudium: 118 Stunden

Lehrveranstaltung: Ernährungsphysiologie und Fütterung des Pferdes (Vorlesung, Übung) *Inhalte*: Das Modul vermittelt spezielle Kenntnisse über Futterverzehr, Verzehrsverhalten, Verdauungsphysiologie und Stoffwechsel des Pferdes sowie zu den davon abgeleiteten Anforderungen an die Energie-, Nähr- und Wirkstoffversorgung in Abhängigkeit von Alter und Nutzungsform. Ausgehend von futtermittelrechtlichen Regelungen, Futtermittelspektrum und Futterzusatzstoffen in der Pferdeernährung sowie speziellen Anforderungen an die Futtermittelqualität stellen nutzungsangepasste Fütterungskonzepte unter besonderer Beachtung der Prävention von ernährungsbedingten Störungen einen weiteren Schwerpunkt dar. Optimierung der Rationsgestaltung für Pferde Übung zur Futteroptimierung In Zusammenarbeit mit Instituten der Universitäten Leipzig, Halle-Wittenberg, Rostock sowie der Tierärztlichen Hochschule Hannover und Praxisvertretern.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Weiterführende Kenntnisse bezüglich der Besonderheiten von Verzehrsregulation und Futteraufnahme beim Pferd, des Verdauungssystems und der altersabhängigen verdauungsphysiologischen Abläufe sowie der Bewertung der Verdaulichkeit; zudem Besonderheiten des Umsatzes der Hauptnährstoffe für Erhaltungs- und Leistungsprozesse und davon abgeleitete Versorgungsempfehlungen; des Weiteren Futtermittelspektrum und rechtlicher Rahmen für den Einsatz von Futtermitteln und Futterzusatzstoffen; swoie alters- und nutzungsabhängige Fütterungskonzepte; Maßnahmen zur Vermeidung fütterungsbedingter gesundheitlicher Störungen	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jürgen Hummel
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.Pferd.0007: Infektions- und Seuchenhygiene in der Pferdehaltung
English title: Infectious disease and hygiene in the horse husbandry</td><td>6 C
4 SWS</td></tr>
<tr><td>Lernziele/Kompetenzen:
Durch die allgemeinen und spezifischen Kenntnisse auf dem Gebiet der Infektiologie und Seuchenhygiene bei Equiden beherrschen die Studierenden auf dem aktuellen Stand von Forschung und Praxis moderne Hygiene- und Haltungskonzepte zu beurteilen und selbständig zu entwickeln. Sie können zielorientiert komplexe Hygiene- und Qualitätssicherungsprogramme etablieren. Sie können die erlernten Fähigkeiten im späteren multidisziplinären Berufsfeld sicher anwenden und vermitteln.</td><td>Arbeitsaufwand:
Präsenzzeit:
56 Stunden
Selbststudium:
124 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Infektions- und Seuchenhygiene in der Pferdehaltung (Praktikum, Vorlesung)
Inhalte:
Infektionskrankheiten und Allergien spielen in der Pferdehaltung seit jeher eine bedeutende Rolle. Dies wird sich im Zuge einer wachsenden Globalisierung in der Pferdezucht, im Pferdesport und in Hobbyhaltungen weiter verstärken. Nach der deutschen Viehverkehrsordnung ist seit dem Jahr 2000 für alle Equiden u.a. aus Gründen der Seuchenhygiene ein Pass obligatorisch. Das Modul soll einen spezialisierten Einblick in das Infektions- und Seuchengeschehen bei Einhufern geben und Verständnis für die Bekämpfungsmöglichkeiten erwecken. Dabei steht der aktuelle Bezug zur späteren vielfältigen Berufspraxis der Studierenden im Vordergrund. Neben einer Einführung in die Qualität und Funktion der körpereigenen Immunabwehrsysteme der Einhufer, werden ausgewählte und aktuell relevante Infektionskrankheiten vorgestellt, einschließlich der Möglichkeiten zur Diagnose, Prophylaxe und Therapie. Hierbei stehen virale Infektionen (z.B. equine Herpesviren EHV1 und EHV4, Influenza, Infektiöse Anämie, Borna'sche Krankheit, Equine Artritis etc.) ebenso im Fokus wie bakterielle Ursachen (ansteckende Gebärmutterentzündung bzw. CEM, Borreliose, Botulismus, Fohlenlähme, Tetanus, Druse) oder Infektionen durch Pilze (z.B. Luftsack- oder Hautmykosen), Protozoen (Beschälseuche durch Trypanosoma equiperdum) und Parasiten. Neben seit langem heimischen Infektionskrankheiten werden auch bereits ausgerottete und reimportierte Pferdeseuchen (z.B. Rotz) behandelt oder in unseren Breiten neu auftretende Seuchen (z.B. Enzephalopathien). Einige der vorgestellten Erreger sind Auslöser gefährlicher Epidemien (Influenza, Tetanus) oder stellen als Zoonoseerreger eine besondere und tödliche Gefahr für den Menschen dar (Tollwut, Rotz). Die Einflüsse der vermehrten Gruppenhaltung von Pferden in Ställen und Herden (Pensions-, Handelsställe, Gestüte etc.) oder die epidemiologische Bedeutung der zunehmenden nationalen und internationalen geographischen Mobilität (nationale und internationale Turniere, Auktionen, Pferdesportveranstaltungen, Zucht, Import, Export) auf die Verbreitung von Erregern werden eingehend behandelt. In diesem Zusammenhang wird auch der immunsuppressive Einfluss von Stress erläutert und die daraus resultierende Gefährdung ganzer Pferdepopulationen durch infizierte, klinisch unauffällige Ausscheider von Infektionserregern. Die Studierenden lernen geeignete Maßnahmen zur Verhinderung seuchenhafter Ausbrüche von Infektionskrankheiten</td><td>4 SWS</td></tr>
</table>

und zum Schutz des einzelnen Pferdes sowie des gesamten Bestandes kennen. Das gilt für die Prinzipien und Entwicklungen von aktiven und passiven Schutzimpfungen, einschließlich eines optimierten Kolostralmilchmanagements, wie auch für neue Möglichkeiten der Immunmodulation, der Behandlung von Allergien und der Optimierung von Haltungsparametern im Sinne einer hygienischen Prophylaxe (Quarantänestallungen z.B. in Gestüten) zusammen mit Koppel- bzw. Weide- und Parasitenmanagement. Bei allen Themengebieten werden die gesetzlichen Grundlagen der Tierseuchenbekämpfung und des Tierschutzes berücksichtigt.	
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Vertiefte Kenntnisse der Biologie und Pathogenese von Tierseuchenerregern bei Einhufern, Infektiologie und Immunnologie bei Equiden, Schutzimpfungen, Allergien, allgemeinen Haltungshygiene, speziellen Hygieneprogramme in Pferdezucht und -sport, Transport- und Umwelthygiene, Tierseuchengesetz und staatlichen Tierseuchenbekämpfung bei Equiden.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jens Tetens
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Pferd.0018: Weidemanagement** *English title: Grazing management*	6 C (Anteil SK: 3 C) 4 SWS

Lernziele/Kompetenzen: Studierende lernen die theoretischen Grundlagen der Grünlandwirtschaft und Weidewirtschaft auf Pferde haltenden Betrieben kennen, wobei methodische und analytische Kompetenzen im Vordergrund stehen. Sie können verschieden strukturierte Daten (Flächen-, Betriebsdaten, verschiedene Kategorien von Variablen) komplex auswerten and analysieren. Sie vertiefen ihre Kenntnisse und Fertigkeiten im Hinblick auf die Vorstellung und Kommunikation der eigenen Projektarbeit. Sie lernen ihre Standpunkte argumentativ zu untermauern und sich mit anderen über Problemlösungsstrategien auszutauschen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Weidemanagement (Vorlesung, Übung, Seminar) *Inhalte*: Anlage von Pferdeweiden, Standorteignung, Böden, Vegetation von Pferdeweiden, Verbesserung und Pflege von Pferdeweiden, Bodenverdichtung, Staunässe, Verunkrautung, Ansprüche der Pferde bei Weidegang, spezifisches Weideverhalten, Ernährung, Bewegung, Leistungsanforderungen an Pferde, Futterproduktion auf der Weide, Winterfutterbereitung für Pferde, Futterkonservierung, Düngung und Nährstoffmanagement, Umweltaspekte, Weidesysteme, Koppel-, Standweide Landschaftspflege mit Pferden. Kennenlernen der wichtigsten Pflanzenarten des Graslands, Techniken der Identifikation von Pflanzenarten bzw. der Aufnahme von Pflanzenbeständen. Durchführung einer Projektarbeit, in der Studierende in Kleingruppen (zwei bis drei Studierende) eigenständig eine Analyse der Weidewirtschaft eines selbst gewählten pferdehaltenden landwirtschaftlichen Betriebs durchführen. Das umfasst die detaillierte Aufnahme der Produktionsbedingungen auf dem Betrieb, die Vegetationsaufnahme der Grünlandschläge sowie Aufnahme der Standort- und Bewirtschaftungsbedingungen des Grünlands. Methoden der Datenaufnahme und komplexen Analyse werden vorgestellt und sollen im Projekt angewendet werden. Vortrag der Ergebnisse im Rahmen des Seminars.	4 SWS
Prüfung: Mündliche Prüfung (ca. 20 min, Gewichtung 60%) und Referat (ca. 15 Minuten, Gewichtung 40%) **Prüfungsvorleistungen:** Durchführung einer Projektarbeit und Vorstellung der Ergebnisse im Rahmen der Veranstaltung **Prüfungsanforderungen:** Tiefere Kenntnis der theoretischen Grundlagen der Grünlandwirtschaft und Weidewirtschaft auf Pferde haltenden Betrieben. Die Studierenden beherrschen die Fähigkeit verschieden strukturierte Daten (Flächen-, Betriebsdaten, verschiedene Kategorien von Variablen) komplex auszuwerten und zu analysieren. Vertiefende Kenntnisse und Fertigkeiten im Hinblick auf die Vorstellung und Kommunikation der eigenen Projektarbeit sind vorhanden.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Johannes Isselstein
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.E11: Socioeconomics of rural development and food security**	6 C 4 WLH

Learning outcome, core skills: Students learn concepts of development and problem-oriented thinking in a development and food security policy context. The identification of interdisciplinary linkages is trained. Building on case-study analyses, course participants can pinpoint appropriate economic and social policies and assess their impacts. These qualifications can also be transferred to unfamiliar situations.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Socioeconomics of rural development and food security (Lecture) *Contents*: This module provides students with an overview of socioeconomic aspects of hunger, malnutrition, and poverty in developing countries. Apart from more conceptual issues and development theories, policy strategies for sustainable rural development and poverty alleviation are discussed and analyzed. Special emphasis is put on problems in the small farm sector. Empirical examples are used to illustrate the main topics.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Concepts and measurement of hunger, malnutrition, and poverty; classification and evaluation of rural development policies	6 C

Admission requirements: none	**Recommended previous knowledge:** Prior knowledge of microeconomics at the BSc level is useful
Language: English	**Person responsible for module:** Prof. Dr. Liesbeth Colen
Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** until 1
Maximum number of students: 120	

Additional notes and regulations: Literature: Text books, research articles and lecture notes.

Georg-August-Universität Göttingen Universität Kassel/Witzenhausen Module M.SIA.E12M: Quantitative research methods in rural development economics	6 C 4 WLH

Learning outcome, core skills: This module will equip students with the skills to plan, develop and implement their own research projects, focusing on key aspects essential for empirical analysis. After successful completion of this course, students should be able to: • Develop relevant research questions • Understand and implement the required steps for primary data collection • Analyse micro data with statistical and econometrics methods • Interpret and communicate empirical findings	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Quantitative research methods in rural development economics (Lecture) *Contents*: The focus of this module is on the design of quantitative research methods in rural development economics, comprising of lectures and practical exercises in the computer lab. The module covers the research process, with specific focus on formulating research questions, collecting primary data and conducting empirical data analysis. One key topic is analysing quantitative data in rural development economics using various statistical and econometric techniques, with a focus on farm and household-level data. The module also covers practical aspects of primary data collection, such as questionnaire development, and implementing household surveys. It also addresses the use of secondary data. Practical application of statistical and econometric methods is reinforced through hands-on exercises in the computer lab, using real-world examples for better understanding.	4 WLH
Examination: Written exam (90 Minutes) (85%) and interim homework assignment (max. 10 pages) (15%) **Examination requirements:** Types of research designs; steps of primary data collection; use and interpretation of descriptive statistics and standard econometric methods; data management.	6 C

Admission requirements: Familiarity with the contents of the module "Socioeconomics of Rural Development and Food Security" is recommended.	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Doris Läpple
Course frequency:	**Duration:**

each summer semester; Göttingen	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 40	

Georg-August-Universität Göttingen Universität Kassel/Witzenhausen Module M.SIA.E13M: Microeconomic theory and quantitative methods of agricultural production	6 C 4 WLH
Learning outcome, core skills: Microeconomic Theory of Agricultural Production Students are familiar with microeconomic approaches and can apply them to analyze issues related to agriculture and rural development. Quantitative Methods in Agricultural Business Economics Students are familiar with quantitative methods used for the analysis and planning of farms and enterprises in the agricultural sector.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Microeconomic theory of agricultural production (Lecture) *Contents*: Consumer theory, producer theory, markets, monopoly situations, risk and uncertainty, economics of technical change, farm household models, sharecropping contracts.	2 WLH
Course: Quantitative methods in agricultural business economics (Lecture) *Contents*: Budgeting, accounting, annual balance sheets, linear programming, finance, investment analysis.	2 WLH
Examination: Written examination (120 minutes) **Examination requirements:** Consumer theory; producer theory; risk; technological progress; farm household models; budgeting and accounting; linear programming; finance; investment analysis.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Oliver Mußhoff Vanessa Bonke
Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 40	

Additional notes and regulations:

Literature:
Text books, research articles and lecture notes.

After successful conclusion of M.Agr.0060 students can not complete M.SIA.E13M

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.E14: Evaluation of rural development projects and policies**	6 C 4 WLH
Learning outcome, core skills: Students know the major methods for the evaluation of rural development projects and policies. They apply these methods for concrete project examples and thus are able to design and carry out evaluations independently.	**Workload:** Attendance time: 40 h Self-study time: 140 h
Course: Evaluation of rural development projects and policies (Lecture) *Contents*: This module teaches and trains the standard methods for the evaluation of rural development projects and policies. In particular, this includes impact assessment as well as cost-benefit analysis. These methods are used for concrete project and policy examples.	4 WLH
Examination: Written exam (90 minutes, 70%) and presentation (ca. 25 minutes, 30%) **Examination requirements:** Cost-benefit analysis; development project evaluation; impact assessment; targeting of projects and interventions	6 C

Admission requirements: none	**Recommended previous knowledge:** Knowledge of the content of the module "Socioeconomics of Rural Development and Food Security" is required.
Language: English	**Person responsible for module:** Ph.D. Bethelhem Legesse Debela
Course frequency: each summer semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 45	

Additional notes and regulations: Literature: Text books, research articles and lecture notes.

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.E19: Market integration and price transmission I**	6 C 4 WLH

Learning outcome, core skills:	**Workload:**
• Students gain insight into the functioning of the price mechanism on agricultural markets and into the determinants of market integration • Students learn to apply econometric methods to analyse horizontal and vertical prices transmission processes (dynamic models, cointegration, including non-linear and regime-dependent error correction models)	Attendance time: 56 h Self-study time: 124 h

Course: Market integration and price transmission I (Lecture)	4 WLH
Contents: 1. Vertical price transmission A simple model of the farm-retail price spread, empirical applications, the effect of market power on vertical price transmission, asymmetric price transmission, the analysis of retail prices 2. Horizontal or spatial price transmission A simple model of spatial equilibrium, empirical applications, accounting for transaction costs in spatial trade, the effects of temporal and spatial data aggregation A list of seminal papers (Gardner, Goodwin and Fackler, Barrett and others) will be provided to students Lecture notes and presentations are made available on StudIP	
Examination: Written examination (90 minutes) **Examination requirements:** • Students are able to explain the economic theory of vertical and spatial/horizontal price transmission and market integration • Students are able to apply the most important methods that are used in price transmission analysis (estimation of error correction models)	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic/intermediate econometrics
Language: English	**Person responsible for module:** Prof. Dr. Stephan von Cramon-Taubadel
Course frequency: Every second summer semester (Start: 2021)	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 2
Maximum number of students: 40	

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Modul M.SIA.E24: Topics in Rural Development Economics I** *English title: Topics in rural development economics I*	6 C 4 SWS
Lernziele/Kompetenzen: Ziel dieses Kurses ist es, den Masterstudierenden an das Lesen und Verstehen von wissenschaftlichen Artikeln heranzuführen und sie mit aktuellen Themen der ländlichen Entwicklungsökonomie vertraut zu machen. Dabei sollen den Studierenden wissenschaftliche Herangehensweise, Methodenwahl und struktureller Aufbau von wissenschaftlichen Artikeln vermittelt werden. Die Studierenden sollen in die Lage versetzt werden, eigene Forschungsfragen auf dem Gebiet der ländlichen Entwicklungsökonomie zu entwickeln und zu konzeptionalisieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Topics in Rural Development Economics I (Vorlesung) *Inhalte*: In diesem Kurs erhalten Masterstudierende einen Überblick über aktuelle Themen der ländlichen Entwicklungsökonomie und über analytische Herangehensweisen zur Bearbeitung relevanter Forschungsfragen. Zu diesem Zweck werden ausgewählte Artikel aus internationalen Fachzeitschriften gelesen, vorgestellt und kritisch diskutiert, sowohl im Hinblick auf inhaltliche als auch auf methodische Aspekte. Die Artikel, die im Kurs behandelt werden, umfassen z.B. folgende Themengebiete: The food system transformation and smallholder farmers; rural livelihood strategies and income diversification; adoption and impacts of modern agricultural technology; economics of nutrition and health; gender and intra-household resource allocation.	4 SWS
Prüfung: Präsentation, Referat oder Korreferat (ca. 10 Minuten, Gewichtung: 40%) und Hausarbeit (max. 4 Seiten, Gewichtung: 60%) **Prüfungsanforderungen:** Konstruktive Beteiligung an der Diskussion in den Vorlesungen, was die Lektüre der angegebenen Artikel voraussetzt. In den Prüfungen sollen die Studierenden demonstrieren, dass sie Forschungsfragen, Methode und Ergebnisse in den behandelten Themengebieten kritisch hinterfragen können.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Meike Wollni
Angebotshäufigkeit: jedes Sommersemester; Göttingen	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.E34: Economic Valuation of Ecosystem Services**	6 C 4 WLH

Learning outcome, core skills: Students get introduced to the essential concepts and methods of interdisciplinary Ecosystem Services (ES) research. Special emphasis will be put on the integrated and systematic assessment of ES, including their dependencies of and impacts on biodiversity, climate change and economic development. Students will familiarize themselves with common methods of economic valuation of ES and learn about different real-world examples of practical implementation. At the same time and working in groups, students will be able to work through different theoretical concepts and methods in the analysis of a fictitious case study that mirrors many conditions and challenges that can be found in real scenarios. This combination of theoretical and practical sessions will allow students to learn how to design economic valuations strategically. That is, covering not only which ES can be valued and how, but also when and why economic valuation can be useful for particular policy purposes and decision-making contexts.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Economic valuation of ecosystem services in developing countries (Seminar) *Contents*: • Integrated and interdisciplinary analysis of ES • Linkages between ES, biodiversity, climate change and development • Selection and application of economic valuation methods • Integration of ES and their values into the policy cycle	4 WLH
Examination: Written exam (50 minutes, grading: 60%) and oral presentation (approx. 30 minutes, grading: 40%) **Examination requirements:** **Examination requirements:** General knowledge about the theoretical background of ES, biodiversity and natural capital, integrated and systematic assessments of ES, and economic valuation methods and their usefulness for decision-making. **Oral presentation requirements:** Students will present in groups the main findings of the assigned fictitious case study. The presentation should highlight the challenges encountered throughout the implementation of economic valuation and provide policy recommendations based on the main findings.	6 C

Admission requirements: none	**Recommended previous knowledge:** M.Agr.0124: Environmental Economics and Policy or similar skills
Language: English	**Person responsible for module:** Prof. Dr. Meike Wollni

Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.E40: Agriculture, Environment and Development**	6 C 4 WLH

Learning outcome, core skills: Dieses Modul widmet sich den ökonomischen und politischen Ursachen für Umweltprobleme im Kontext von Landwirtschaft und Entwicklung. Globale Herausforderungen wie Klimawandel, Nachhaltige Entwicklung und Armut bilden die Themenschwerpunkte. Es werden zunächst ausgewählte umwelt- und ressourcenökonomische Grundlagen vermittelt und sodann wichtige Aspekte wie die Nutzung von Gemeingütern, sowie Verschmutzungskontrolle und Klimaschutz in internationalen Agrar-Umwelt-Kontexten vertieft.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Agriculture, Environment and Development (Lecture, Exercise, Seminar) *Contents*: Dieses Modul bietet in der ersten Semesterhälfte eine Kombination aus Vorlesung und Übung, wobei die theoretischen Konzepte aus der Vorlesung in jeweils zugehörigen Übungen vertieft und mit Anwendungsbeispielen aus Wissenschaft und Praxis ergänzt werden. In der zweiten Semesterhälfte präsentieren die Studierenden zu ausgewählten Themen eine Analyse einer wissenschaftlichen Publikation. Dies dient dazu, dass die Studierenden erlernte Inhalte gezielt selbstständig vertiefen und in der Beurteilung einer Fallstudie anwenden können. Inhalte: • Grundlagen (Marktversagen, natürliche Ressourcen, Naturkapital) • Effizienz und Nachhaltigkeit: Konzepte, Kriterien und Anwendung • Ökonomie von Gemeingütern in Entwicklungsländern • Ökonomie der Landnutzung in Entwicklungsländern • Ökonomie der Wassernutzung in Entwicklungsländern • Armut, Entwicklung und Umwelt • Landwirtschaft und Klimawandel • Globale Initiativen und Internationale Abkommen zur Nachhaltigen Entwicklung und Klimaschutz	4 WLH
Examination: Klausur (60 Minuten, 70%) und Präsentation (ca. 20 Minuten, 30%) **Examination prerequisites:** Regelmäßige Teilnahme am Seminar **Examination requirements:** Ausgewählte Grundlagenkenntnisse der Umwelt-und Ressourcenökonomie. Verständnis wichtiger Konzepte wie ökonomische Effizienz und Nachhaltigkeit. Kenntnisse wichtiger Zusammenhänge zwischen Landwirtschaft, Ressourcennutzung, Nachhaltigkeit und Klimawandel im Entwicklungskontext. Diskussion gegenwärtiger Handlungsansätze.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language:	**Person responsible for module:**

English	Prof. Dr. Meike Wollni
Course frequency: each summer semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 40	

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.E42: Agriculture, Nutrition and Sustainable food systems**	6 C 4 WLH
Learning outcome, core skills: Students learn how food systems and food policies are shaping what we eat, how we produce our food, and how this links to sustainable development in a global context. The course covers food systems in both developing and developed countries. Students learn to engage in a critical debate on the role of food policies and other drivers in shaping what we consume, how this links to food production and sustainable development, including health, environment and the economy. Students learn to analyze these themes by engaging in basic data analysis, case studies and the critical analysis and exposition of arguments.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Agriculture, Nutrition and Sustainable food systems (Lecture) *Contents*: This module introduces students to apply systems thinking to the global challenges of food security, nutrition, health and sustainability. It introduces the relevant concepts, analyses the drivers and food policies that may transform food systems using an interdisciplinary approach. Every lecture is accompanied by a more practical session in which basic analysis of data (using Stata) or comparative and critical analysis are applied to the specific themes or policies covered in the lecture. Course material consists of presentations and lecture notes. A list of scientific reports, research articles and relevant data will be provided to students. *Course frequency:* each winter semester	4 WLH
Examination: Written examination (60 minutes, 50%) and paper (max. 15 pages, 50%) **Examination requirements:** Students are able to explain the concepts related to food systems, to analyse food policies, and to generate and interpret relevant statistics related to nutrition, food policies and global sustainability. In a written assignment, students provide critical analysis of a specific food system and/or food policy intervention.	6 C

Admission requirements: none	**Recommended previous knowledge:** Prior knowledge of microeocnomics at BSc level is useful. Prior experience with Stata or SPSS may be helpful but is not a requirement.
Language: English	**Person responsible for module:** Prof. Dr. Liesbeth Colen
Course frequency: each summer semester	**Duration:** 1 semester[s]

Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 45	

<table>
<tr><td>Georg-August-Universität Göttingen
Universität Kassel/Witzenhausen
Module M.SIA.E45: Introduction to choice experiments in food economics</td><td>6 C
4 WLH</td></tr>
</table>

<table>
<tr><td>Learning outcome, core skills:
Students experience the entire process of (choice) experimental practice in the field of social sciences, including its possibilities, limitations and interpretation of results
Students learn how to identify and narrow down a research question into a testable hypothesis. Students learn how to test such a hypothesis by identifying control and treatment groups, the importance of power calculations, sampling design and analysis of data.
Students improve their general understanding of the scientific practice, correct interpretation of scientific results and their contribution to (public) decision making.
Students train their teamworking skills, through brainstorming exercises, discussions, self-organization and distribution of tasks of the team.</td><td>Workload:
Attendance time:
55 h
Self-study time:
125 h</td></tr>
</table>

<table>
<tr><td>Course: Introduction to choice experiments in food economics (Block course, Exercise)
Contents:
This module consists of two blocks.
The first block concerns the introduction to choice experimental practice and the set-up of a small online experiment addressing a specific research question in the field of agricultural, food or nutrition economics.
The second block concerns the analysis of the obtained data and interpretation of results.
Students will work in groups of 4-5 students to identify and narrow down a research question in the field of agriculture, food or nutrition economics, learn how to translate a research question into a testable hypothesis, design the choice experiment, perform power calculations, and effectively launch the online survey. In the second part, the results of the survey will be analysed and each group will present the results, limitations and lessons learned.</td><td>4 WLH</td></tr>
<tr><td>Examination: Term Paper (max. 10 pages, 70%) and presentation (approx. 20 minutes, 30%)
Examination requirements:
Short paper describing the set-up and execution of the experiment (70%), and presentation presenting the approach, results and limitations/lessons learned (30%)</td><td>6 C</td></tr>
</table>

<table>
<tr><td>Admission requirements:
Econometrics I (M.WIWI-QMW.004), M.SIA.E12M: Quantitative research methods in rural development economics</td><td>Recommended previous knowledge:
Basic statistics/econometrics

Students proof that they are capable of</td></tr>
</table>

Or a similar introduction to statistics or econometrics	• Identifying research question and developing a testable hypothesis • Collaborate in groups to brainstorm, guide the discussion towards a practically implementable outcome, and implement the experiment • Analyse, interpret and discuss experimental results
Language: German, English	**Person responsible for module:** Prof. Dr. Liesbeth Colen
Course frequency: each summer semester; Göttingen	**Duration:**
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 12	

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.I10M: Applied statistical modelling**	6 C 5 WLH

Learning outcome, core skills: Students have a detailed understanding of the concepts of statistical modelling, regression analyses and analyses of variance. They are familiar with the basic concepts of 'linear models', 'generalized linear models' and 'non-parametric estimation procedures', which now belong to the standard methods in applied statistics. Students are able to practically apply these methods and carry out statistical analyses in soil, plant and animal sciences using the statistical software R. They are able to apply the acquired skills in the analysis of their own MSc (and PhD) datasets.	**Workload:** Attendance time: 60 h Self-study time: 120 h

Course: Applied statistical modelling (Lecture, Exercise) *Contents*: Course Part I: Statistical analyses in soil and plant sciences (Lecture, Internship) • Review of statistical concepts (boxplots, QQ plots, distributions, classical tests, correlations, analyses of count and proportion data) • Experimental design: populations and samples • Introduction to the software R • Regression (multiple linear, polynomic, non-linear) • Statistical modelling, model types and model simplifications • Transformations Course Part II: Statistical analyses in animal sciences (Lecture, computer practical) • General aspects of hypotheses formulation and testing • Data distribution (normal, categorical, Poisson) and model selection criteria • Analyses of variance, post-hoc tests • Non-parametric test procedures • Mixed model procedures (linear, non-linear) • Formulation of statistical models and basic programming in R	5 WLH
Examination: Written examination (120 minutes) **Examination requirements:** One written exam with two parts. Knowledge of basic statistical terms and approaches, linear and generalized linear models and non-parametric estimation procedures. Ability to apply the methods and models to real data by using the software package R.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge (B.Sc. level) of applied statistics
Language: English	**Person responsible for module:** Prof. Dr. Bernard Ludwig
Course frequency: each summer semester; Witzenhausen	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

twice	
Maximum number of students: 25	

Additional notes and regulations:

Literature:

Lecture notes

- Crawley, M.J. 2012. The R Book, Wiley
- Dobson A. & Barnett A. (2008) An Introduction to Generalized Linear Models, Chapman & Hall.
- Field, A., Miles, J., Field, Z. 2012. Discovering Statistics using R, SAGE
- Mrode R. A. (2005) Linear Models for the Prediction of Animal Breeding Values, CABI Publishing.
- Searle S. R. (1982) Matrix Algebra Useful for Statistics, Wiley Series in Probability and Statistics.

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Modul M.SIA.P22: Management of tropical plant production systems** *English title: Management of tropical plant production systems*	6 C 4 SWS
Lernziele/Kompetenzen: Kenntnisse der botanischen, ökologischen und agronomischen Fakten der vorgestellten Nutzpflanzen und Anbausysteme, Zuordnung von Nutzpflanzen und Anbausystemen zu verschiedenen Standortbedingungen und systemorientierte Beurteilung einer nachhaltigen Produktion an ausgewählten Standorten.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
Lehrveranstaltung: Management of tropical plant production systems (Vorlesung) *Inhalte*: Vorstellung der wichtigsten Nutzpflanzen der Tropen und Subtropen bezüglich Botanik, Morphologie, Herkunft, klimatischer und ökologischer Ansprüche, Anbausystem, Ernteverfahren, Bedeutung in Landnutzungssystemen, Nutzung als Nahrungsmittel, Futter, Rohstoff und zur Energiegewinnung aus Biomasse. Diskussion der verschiedenen Anbausysteme in den Tropen und Subtropen und des spezifischen Managements für eine nachhaltige Steigerung der Produktivität **Literatur** Rehm, S., Espig, G. 1991: The Cultivated Plants of the Tropics and Subtropics. Verlag Josef Margraf. Weikersheim, Germany; lecture notes	4 SWS
Prüfung: Written exam (90 minutes) or oral exam (ca. 30 minutes) **Prüfungsanforderungen:** Wissen der botanischen, ökologischen und agronomischen Fakten der vorgestellten Nutzpflanzen und Anbausysteme. Kenntnisse der Zuordnung von Nutzpflanzen und Anbausystemen an verschiedene Standortbedingungen, sowie systemorientierte Beurteilung einer nachhaltigen Produktion an ausgewählten Standorten.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Reimund Paul Rötter
Angebotshäufigkeit: jedes Wintersemester; Göttingen	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 35	

Bemerkungen: Die schriftliche Prüfung erfolgt am ersten, die mündliche Prüfung am zweiten Termin.

Georg-August-Universität Göttingen **Module M.WIWI-BWL.0157: Resourcing in Entrepreneurship**	6 C 2 WLH

Learning outcome, core skills: After completing this seminar, students will have an overview of diverse theoretical perspectives on resourcing in entrepreneurship based on scientific research papers. Students gain an analytical understanding of typical challenges entrepreneurs face throughout the founding process, focusing on resource acquisition. The strong research focus does not only enable students to identify, understand and see through common challenges, conflicts, and troubles throughout the entrepreneurship process, but also to discuss, evaluate, and question research findings and scientific debates.	**Workload:** Attendance time: 28 h Self-study time: 152 h

Course: Resourcing in Entrepreneurship (Seminar) *Contents*: No doubt, Silicon Valley is one of the world’s leading hubs for technological innovation. Pioneering companies like Google, Facebook or PayPal were founded by visionary entrepreneurs with growth ambition. Yet, despite the myth of a solitary genius tinkering in her garage, such entrepreneurial activities and innovations are only possible if diverse actors work together in manifold ways. Here, a *major challenge* becomes apparent: Although such entrepreneurial activities require manifold, comprehensive resources to work on innovative ideas, develop new products and grow an organization, in most cases, entrepreneurs do not possess all necessary resources. Hence, resourcing becomes an outstandingly important challenge for entrepreneurs. In this course, we discuss diverse approaches to resource acquisition from a research-based perspective. For example, the respective environment, e.g. the entrepreneurial ecosystem, might provide critical resources for the founding process. Not only entrepreneurs cluster in regions like Silicon Valley, London or Paris, but also investors, research universities, skilled work forces, mentors, and co-working spaces, creating a dynamic setting for technological innovation and high growth entrepreneurship. How do entrepreneurial ecosystems in different regions look like? How do they promote entrepreneurial activities? Leveraging resources from such external actors and environments becomes central. Thus, this course discusses questions like: What kind of relationships do new ventures need? How do entrepreneurs form such network ties to acquire funding or first customers? How do their networks evolve throughout the founding process? What does resourcing mean in a digital age? Which role do entrepreneurial teams play?	2 WLH
Examination: Portfolio (40% paper presentation, 60% take-home-exams) **Examination requirements:** Regular attendance.	6 C

Examination requirements: Students have to show that they are able to apply the theoretical concepts discussed in the seminar, reflect them critically, and develop practical implications rooted in a strong theoretical foundation. Students have to read and critically discuss scientific papers.	

Admission requirements: none	**Recommended previous knowledge:** Experience with discussing scientific papers or willingness to learn it.
Language: English	**Person responsible for module:** Prof. Dr. Katharina Scheidgen
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 4
Maximum number of students: 20	

Georg-August-Universität Göttingen **Modul M.WIWI-BWL.0158: Entrepreneurial Projects** *English title: Entrepreneurial Projects*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden sind nach erfolgreicher Teilnahme des Moduls in der Lage eigenständig und in interdisziplinären Teams auch komplexe Projektprozesse im Bereich Entrepreneurship und Innovation zu planen, zu kontrollieren und umzusetzen. Dabei werden sowohl klassische Managementmethoden wie Meilensteintrendanalysen, als auch agile Methoden wie Scrum genutzt. Die Organisation in Form von Arbeitspaketen, die Identifizierung von benötigten Ressourcen und das erfolgreiche Erreichen von Meilensteinen stehen im Vordergrund. Im Rahmen dieser Tätigkeiten arbeiten die Teilnehmenden im Team und nehmen unterschiedliche Teampositionen ein, z.B. Projektmanager*in, Product Owner*in etc. Zum Ende der Veranstaltung werden Möglichkeiten zur zielgruppenspezifischen Kommunikation der Projektergebnisse dargestellt und geübt, wie beispielsweise durch Pitches. Die Master-Studierenden schärfen und vertiefen ihre instrumentalen und systemischen Kompetenzen und bauen umfassende entscheidende, kommunikative sowie fachliche Kompetenzen aus, um auch in hochgradig ungewissen Situationen, wie sie Innovationsprozesse und Entrepreneurship charakterisieren, kooperativ zusammenzuarbeiten, zu überzeugen und ein potenzielles Produkt zu entwickeln. Indem die Studierenden an komplexen und praxisnahen Problemlösungen im Bereich Entrepreneurship und Innovation arbeiten, erweitern sie nicht nur ihre Fachkompetenzen, sondern auch ihre überfachlichen Kompetenzen, da nicht nur das bestehende Wissen vertieft, sondern durch die Entrepreneurship-Lehre auch das Wissen in der Breite erweitert wird.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Entrepreneurial Projects (Projektseminar) *Inhalte*: Die Studierenden entwickeln eigene innovative Ideen, arbeiten an Gründungsprojekten, oder erarbeiten innovative Lösungen für Probleme bestehender Unternehmen mit unternehmerischen Methoden; im Sinne von Intrapreneur*innen. Diese Projekte werden auf der Basis von gemeinsam ausgearbeiteten Projektplänen hinsichtlich Planung, Kontrollierung und Umsetzung kritisch hinterfragt. Dabei werden die Kernfunktionalitäten der möglichen Projektergebnisse herausgearbeitet und auf erste Prototypen angewendet. Falls möglich sollen potenzielle Anwender*innen aktiv in den Projektprozess eingebunden und Feedback eingeholt werden. Die Studierenden werden dazu ermutigt ihre Ergebnisse Schritt für Schritt durch kurze Sprints und eine iterative Entwicklung voranzutreiben. **1. Projekt- und Prozessmanagement** Es werden klassische (z.B. Meilensteintrendanalyse) sowie agile Projektmanagement-Methoden (z.B. Scrum) behandelt. Darüber hinaus wird die Formulierung von Arbeitspaketen und die Entwicklung in Sprints Teil des Kurses sein. **2. Prototyping**	4 SWS

Die Studierenden entwickeln Ideenskizzen und Testszenarien. Sie lernen Tools für den erfolgreichen Bau von Prototypen kennen und auszuwählen. Zudem lernen sie verschiedene Möglichkeiten zum Testen von Prototypen kennen. **3. Pitch Training** Im Pitch-Training werden zielgruppenspezifische Ansprachen von unterschiedlichen Stakeholder-Gruppen geübt. Es soll gezeigt werden, wie Kernbotschaften einfach und unmissverständlich herausgearbeitet werden können. Der eigene Auftritt und das Präsentieren der Kernbotschaften stehen im Vordergrund der Veranstaltung.	
Prüfung: Präsentation (ca. 5 Min., Pitch) und schriftliche Ausarbeitung (max. 25 Seiten) **Prüfungsvorleistungen:** regelmäßige Teilnahme	6 C

Prüfungsanforderungen: Die Präsentation ist in Form eines Pitches zu erbringen und umfasst folgende Bestandteile: Business Model Canvas, Pitch und Pitch-Deck. Ziel der Präsentation ist es, potenzielle Investor:innen und/ oder andere relevante Stakeholder zu überzeugen. Es wird darüber hinaus auch das Zuschneiden der Präsentationen auf die Zielgruppe bewertet. Durch die schriftliche Ausarbeitung weisen die Studierenden nach, dass sie (a) über ein fundiertes und umfassendes methodisches Wissen verfügen, das hilft, sowohl eigenständig als auch im Team ‚entrepreneurial projects‘ zu planen, zu kontrollieren und umzusetzen. Des Weiteren zeigen die Kursteilnehmenden anhand der zu prüfenden Leistung, dass sie (b) die Zusammenhänge von einem in Arbeitspakten organisierten Projektprozess unter Einbeziehung der benötigten Ressourcen anhand einer Meilensteinkontrolle oder in Form agiler Projektmanagementmethoden tiefgreifend verstanden haben. Dabei zeigen sie, dass sie (c) eine zielgruppenspezifische Umsetzung von potenziell auslieferbaren Produkten und (d) eine zielgruppenspezifische Ausarbeitung von Präsentationen beherrschen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Katharina Scheidgen
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 4
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0003: Statistical genetics, breeding informatics and experimental design**	6 C 4 WLH

Learning outcome, core skills: Novel biotechnological methods allow the production of very large data sets (gene sequences, genotypes, transcriptomes) at decreasing costs. Students learn about statistical and computational methods to use these records for breeding issues. Furthermore, the main experimental designs to plan, implement, and evaluate targeted and efficient experiments for data generation will be treated.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Statistical genetics, breeding informatics and experimental design (Lecture, Exercise) *Contents*: • Gene Expression Analysis • Genome-wide association analysis • QTL mapping • Statistical hypothesis testing • Regression methods • Analysis of variance • Multiple testing • Experimental designs (block designs, randomized designs, Latin squares) • Sample size estimation • Introduction to programming • Fundamentals of databases Literature: Andrea Foulkes: Applied Statistical Genetics with R	4 WLH
Examination: Written examination (60 minutes) **Examination requirements:** Profound knowledge of statistics and informatics methods to use them for breeding issues.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basics in statistics and genetics
Language: English	**Person responsible for module:** Prof. Dr. Armin Schmitt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0006: Breeding informatics**	6 C 4 WLH

Learning outcome, core skills: Students acquire their knowledge of informatics methods to evaluate large datasets for breeding issues.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Breeding informatics (Lecture, Exercise) *Contents*: • Bascics of Linux operating system • Basic data structures • Programming in R • Regular expressions • Design and implementation of pipelines for data analysis • Shell scripts on Linux (gawk, sed) • Relation of genotype - phenotype • Basic concepts of bioinformatics	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Profound knowledge of informatics methods to evaluate large datasets for breeding issues.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of molecular genetics, statistics, programing
Language: English	**Person responsible for module:** Prof. Dr. Armin Schmitt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen Module M.iPAB.0014: Data Analysis with R	3 C 2 WLH
Learning outcome, core skills: The students will be able to use methods provided by the statistical package R to perform the analysis of data sets that are typical in the life sciences. A core skill is the identification, usage and evaluation of online resources (e.g. packages and data sets).	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Data Analysis with R (Block course, Lecture, Exercise) *Contents*: The fundamental concepts of the programming package R will be presented and deepened during practical exercises. Statistical methods will be recapitulated if necessary. Special emphasis is put on visualization methods. Literature: Wiki-book "R programming" https://en.wikibooks.org/wiki/R_Programming "R for Beginners" by Emanuel Paradis https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf "R tips" by Paul E. Johnson http://pj.freefaculty.org/R/Rtips.pdf	2 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Ability to analyze typical data sets with the statistical package R and interpretation of the results.	3 C

Admission requirements: none	**Recommended previous knowledge:** Knowledge of basic statistics concepts
Language: English	**Person responsible for module:** Thomas Martin Lange
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 4
Maximum number of students: 24	

Georg-August-Universität Göttingen **Module M.iPAB.0015: Applied Machine Learning in Agriculture with R**	6 C 4 WLH
Learning outcome, core skills: Modern agricultural research involves more and more the analysis of large datasets comprising mesaurements of several variables. This module aims to teach interested students fundamental analysis skills that permit them to cope with such data sets. In more detail, the techniques that will be treated include: • clustering • artificial neural networks • support vector machine • decision trees • random forests • feature selection Involved mathematical formalism will be avoided. The focus is rather on: • gaining an intuitive understanding of the techniques • to develop an understanding about which type of problem can be treated with which technique • the application of the techniques using machine learning-functions under R • the graphical visualisation of the results • and the interpretation of the results The teaching will be based on the analysis of published real data sets from agricultural research projects as far as possible.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Applied Machine Learning in Agriculture with R (Block course) *Contents*: The course consists of lectures, exercises and project work. After the lectures and the exercises the students will have to carry out a project work that must be finished within eight weeks after the end of the lectures. The students as well as the other research groups are welcome to suggest topics, possibly questions related to their master thesis can be treated. The project work should be a concise written report of about ten pages in which one or several of the techniques that were treated in the course are applied.	4 WLH
Examination: Oral examination (approx. 20 minutes, 60%) and term paper (max. 10 pages, 40%) **Examination requirements:** • Knowledge about the analysis of big-data sets with the statistical package R and interpretation of the results. • Knowledge about different clustering algorithms • Analysis of real agricultural data sets by applying different machine learning-functions under R • Knowledge about feature selection approaches	6 C

Admission requirements: Recommended previous knowledge: Basic knowledge of R	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Felix Heinrich
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.iPAB.0019: Scientific Project: scientific methods, procedures and practical skills in animal and plant breeding**	9 C 6 WLH
Learning outcome, core skills: Advanced knowledge of scientific methods, procedures and practical skills in the field of animal as well as plant breeding acquired by the active participation in a research project. Students also gain key competencies such as team working, interdisciplinary working, and self-organization.	**Workload:** Attendance time: 60 h Self-study time: 210 h
Course: Scientific Project: scientific methods, procedures and practical skills in animal and plant breeding *Contents*: Working on a scientific project in the different fields of breeding research. Testing of scientific hypotheses, experimental design, analysis of genotyping data, data analysis, interpretation and presentation of the research results.	6 WLH
Examination: Term paper (max. 20 pages) **Examination requirements:** Active and independent working on a plant or animal breeding related scientific issue.	9 C

Admission requirements: The students, who are enrolled in the “Integrated plant and animal breeding (IPAB)” program, must get an approval from the program coordinator at least one month prior to the desired start date of the project.	**Recommended previous knowledge:** Basics of plant and animal breeding, statistics, and scientific writing
Language: English	**Person responsible for module:** Thomas Martin Lange
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Modul S.RW.1261: Vertragsgestaltung in der agrarrechtlichen Praxis** *English title: Drafting agricultural contracts*	6 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls „Vertragsgestaltung in der agrarrechtlichen Praxis“ • haben die Studierenden grundlegende Kenntnisse von den in einem landwirtschaftlichen Unternehmen gängigen Vertragsarten und Rechtsbereichen (Kaufrecht, landwirtschaftliches Erbrecht, Pachtrecht, Grundstücksverkehrsrecht, landwirtschaftliches Sozialversicherungsrecht, Beihilferecht sowie agrarproduktspezifische Regelungen) erlangt; • haben die Studierenden gelernt, die verschiedenen allgemeinen Fragen des Landpacht-, agrarspezifischen Kaufrechts, des Pacht- und Grundstückskaufrechts Vertragstypen zuzuordnen; • kennen die Studierenden die rechtlichen Grundlagen und Besonderheiten bei Liefer-, Anbau-, Kooperations- und Bewirtschaftungsverträgen, des Agrarsozialrechts und seine Auswirkungen auf die Vertragsgestaltung; • kennen die Studierenden die dogmatischen Konzeptionen der Vertragsgestaltung in ihrer systematischen, ideellen und praktischen Bedeutung; • kennen die Studierenden die Methoden der allgemeinen Vertragsgestaltung und deren Grundlagen sowie die damit im Zusammenhang stehenden spezifischen Praxisprobleme in der agrarrechtlichen Tätigkeit und können diese anwenden; • haben die Studierenden rechtliches Fachwissen und ein Grundverständnis für die ökonomischen und rechtlichen Themen und Problemstellungen in der Agrarwirtschaft anhand von Vertragsbeispielen und Fällen erlernt; • beherrschen die Studierenden die Fähigkeit, die im Rahmen einer agrarisch orientierten Tätigkeit oder in ihrem Beruf auftretenden juristischen Fragen einzuordnen, zu behandeln und zu beantworten. Sie haben gelernt, ein juristisches und ökonomisches Problembewusstsein im Bereich der Vertragsgestaltung zu entfalten sowie für juristische Probleme Lösungen zu entwickeln. • sind die Studierenden in der Lage, die erworbenen Kenntnisse bei der Lösung einschlägiger Fälle umzusetzen und sich mit den aufgeworfenen Rechtsfragen kritisch auseinanderzusetzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden
Lehrveranstaltung: Vertragsgestaltung in der agrarrechtlichen Praxis (Vorlesung)	2 SWS
Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C
Prüfungsanforderungen: • grundlegende Kenntnisse im Agrarrecht und der agrarrechtlichen Vertragsgestaltung aufweisen,	

• ausgewählte Tatbestände der agrarrechtlichen Vertragsgestaltung beherrschen, • die zugehörigen methodischen Grundlagen beherrschen und • systematisch an einen agrarrechtlichen Fall zur Vertragsgestaltung herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul S.RW.1262: Grundlagen des Agrarrechts** *English title: Basics of agricultural law*	6 C 2 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Nach erfolgreichem Absolvieren des Moduls „Grundlagen des Agrarrechts “ • haben die Studierenden Grundkenntnisse der agrarwirtschaftlich relevanten Bereiche des Rechts erlangt; (WTO-Recht, Europarecht, Verfassungsrecht, Verwaltungsrecht / Wirtschaftsverwaltungsrecht, , Eigentumsordnung der Landwirtschaft, Landwirtschaftliches Erbrecht, Landpachtrecht, Gesellschaftsrechtliche Formen bei landwirtschaftlichen Betrieben, Recht des ländlichen Raumes, Grundstückverkehrsrecht; Recht des Ländlichen Raums) • haben die Studierenden rechtliches Fachwissen und ein Grundverständnis für die ökonomische und soziale Bedeutung der Agrarwirtschaft und des Ländlichen Raums erlernt. Dazu gehören die juristische und ökonomische Fachsprache, der Umgang mit dem komplexen Normsystem des Agrarrechts und das Erkennen von Strukturzusammenhängen im Recht, • beherrschen sie die Fähigkeit, die im Rahmen einer agrarisch orientierten Tätigkeit oder ihres Berufes auftretenden juristischen Fragen zu erkennen und zu behandeln bzw. zu beantworten • sind die Studierenden in der Lage ein juristisches und ökonomisches Problembewusstsein zu entfalten sowie für juristische Probleme Lösungen zu entwickeln. Inhalte: I. Begriff des Agrarrechts II. Geschichte des Agrarrechts III. Rechtsquellen des Agrarrechts IV. Prinzipien des Agrarrechts V. Grundbegriffe des Agrarrechts 1. Landwirtschaft 2. Landwirt/in 3. Landwirtschaftlicher Betrieb VI. Landwirtschaft und Verfassung VII.Zivilrechtliche Sonderregelungen des landwirtschaftlichen Betriebes 1. Pachtrecht 2. Familien und Erbrecht 3. HGB	Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

Lehrveranstaltung: Grundlagen des Agrarrechts (Vorlesung)	2 SWS
Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C

Prüfungsanforderungen:	
Durch die Modulprüfung weisen die Studierenden nach, dass sie • grundlegende Kenntnisse im Agrarrecht aufweisen, • ausgewählte Tatbestände des Agrarrechts beherrschen,	

• die zugehörigen methodischen Grundlagen beherrschen und • systematisch an einen agrarrechtlichen Fall herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul S.RW.1263: Europäisches Agrarrecht** *English title: European agricultural law*	6 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls „Europäisches Agrarrecht“ • haben die Studierenden Kenntnisse der agrarwirtschaftlich relevanten Bereiche des Europarechts erlangt; (Gemeinsame Agrarpolitik; Wettbewerbsrecht, insbesondere Kartellrecht; Umweltrecht) • haben die Studierenden rechtliches Fachwissen und ein Grundverständnis für das Zusammenspiel der verschiedenen Rechtsebenen, die die Agrarwirtschaft bestimmen entwickelt. Dazu gehören die juristische und ökonomische Fachsprache, der Umgang mit dem komplexen Normsystem des Agrarrechts und das Erkennen von Strukturzusammenhängen im Recht. • Sie beherrschen die Fähigkeit, die im Rahmen einer agrarisch orientierten Tätigkeit oder ihres Berufes auftretenden juristischen Fragen zu behandeln bzw. zu beantworten und hierfür ein juristisches und ökonomisches Problembewusstsein zu entfalten sowie für juristische Probleme Lösungen zu entwickeln. • kennen die Studierenden die dogmatischen Konzeptionen des europäischen Agrarrechts in ihrer systematischen, interdisziplinären und praktischen Bedeutung; • kennen die Studierenden die spezifischen Methoden der Gesetzesanwendung im Mehrebenensystem des öffentlichen Agrarrechts (Völker-, europa-, bundes- und landesrechtliche Ebene) und können diese anwenden; • sind die Studierenden in der Lage, die erworbenen Kenntnisse bei der Lösung einschlägiger Fälle umzusetzen und sich mit den aufgeworfenen Rechtsfragen kritisch auseinanderzusetzen. Inhalte: I. Die Bedeutung der Landwirtschaft und der Fischerei in der EU II. Agrarrecht im Europäischen Primärrecht III. Die Gemeinsame Agrarpolitik IV. Der Anwendungsbereich der Gemeinsamen Agrarpolitik (GAP) und der Gemeinsamen Fischereipolitik (GFP) V. Die Entwicklung der GAP VI. Wirtschaftsvölkerrechtlicher Rahmen VII. Die Ziele der GAP VIII.Die Säulen der GAP 1. Gemeinsame Marktorganisation 2. Die Entwicklung des ländlichen Raumes IX. Das Verhältnis der GAP zu anderen EU- Politiken X. Die Gemeinsame Fischereipolitik (GFP) XI. Kontrolle	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

Lehrveranstaltung: Europäisches Agrarrecht (Vorlesung)	2 SWS
Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C

Prüfungsanforderungen: Durch die Modulprüfung weisen die Studierenden nach, dass sie • grundlegende Kenntnisse im europäischen Agrarrecht aufweisen, • ausgewählte Tatbestände des europäischen Agrarrechts beherrschen, • die zugehörigen methodischen Grundlagen beherrschen und • systematisch an einen Fall aus dem europäischen Agrarrechts herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul S.RW.1264: Agrarumweltrecht** *English title: Law of the agricultural environment*	6 C 2 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Nach erfolgreichem Absolvieren des Moduls "Agrarumweltrecht" • haben die Studierenden Kenntnisse in den für die Landwirtschaft relevanten Bereichen des Umweltrechts erlangt; • kennen die Studierenden die dogmatischen Konzeptionen des Agrarumweltrechts in ihrer systematischen, interdisziplinären und praktischen Bedeutung; • kennen die Studierenden die spezifischen Methoden der Gesetzesanwendung im Mehrebenensystem) des Agrarumweltrechts (Völker-, europa-, bundes und landesrechtliche Ebene) und können diese anwenden; • sind die Studierenden in der Lage, die erworbenen Kenntnisse bei der Lösung einschlägiger Fälle umzusetzen und sich mit den aufgeworfenen Rechtsfragen kritisch auseinanderzusetzen. Inhalte: 1. Teil: Rechtsquellen des Umweltrechts • Umweltrecht des Bundes und der Länder • Umweltvölkerrecht • Europäisches Umweltrecht 2. Teil: Allgemeines Umweltrecht • Prinzipien des Umweltrechts • Instrumente des Umweltrechts • Mediation • Umweltverfassungsrecht • Umweltverwaltungsrecht • Rechtsschutz im Umweltrecht 3. Teil: Besonderes Umweltrecht • Immissionsschutzrecht • Raumordnungs- und Landesplanungsrecht • Tierschutzrecht • Gewässerschutzrecht • Bodenschutzrecht • Gefahrstoffrecht • Gentechnikrecht • Umwelthaftungsrecht • Energierecht • Klimaschutzrecht	Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

Lehrveranstaltung: Agrarumweltrecht (Vorlesung)	2 SWS

Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C

Prüfungsanforderungen: Durch die Modulprüfung weisen die Studierenden nach, dass sie • grundlegende Kenntnisse im Agrarumweltrecht aufweisen, • ausgewählte Tatbestände des Agrarumweltrecht beherrschen, • die zugehörigen methodischen Grundlagen beherrschen und • systematisch an einen Fall aus dem Agrarumweltrecht herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul S.RW.1265: Agrarverwaltungsrecht** *English title: Agricultural administrative law*	6 C 2 SWS

Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls „Agrarverwaltungsrecht“ • haben die Studierenden Kenntnisse der agrarwirtschaftlich relevanten Bereiche des Verwaltungsrechts (Verwaltungsrecht / Wirtschaftsverwaltungsrecht, , Eigentumsordnung der Landwirtschaft, Landpachtrecht, Gesellschaftsrechtliche Formen bei landwirtschaftlichen Betrieben, Recht des ländlichen Raumes, Grundstückverkehrsrecht, Recht des Ländlichen Raums) und dessen Einbindung in das rechtliche Mehrebenensystem erlangt. • haben die Studierenden rechtliches Fachwissen und ein Grundverständnis für die ökonomische und soziale Bedeutung der Agrarwirtschaft und des Ländlichen Raums erlernt. Dazu gehören die juristische und ökonomische Fachsprache, der Umgang mit dem komplexen Normsystem des Agrarrechts und das Erkennen von Strukturzusammenhängen im Recht. • haben die Studierenden Kenntnisse im öffentlichen Agrarrecht und insbesondere in den für die Landwirtschaft relevanten Bereichen des Verwaltungsrechts erlangt; • kennen die Studierenden die dogmatischen Konzeptionen des Agrarverwaltungsrechts in ihrer systematischen, interdisziplinären und praktischen Bedeutung; • kennen die Studierenden die spezifischen Methoden der Gesetzesanwendung (im Mehrebenensystem) des öffentlichen Agrarrechts ; • sind die Studierenden in der Lage, die erworbenen Kenntnisse bei der Lösung einschlägiger Fälle umzusetzen und sich mit den aufgeworfenen Rechtsfragen kritisch auseinanderzusetzen. Inhalte: I. Landwirtschaft als Adressatin der Verwaltung II. Agrarverwaltungsrecht als besonderes öffentliches Wirtschaftsrecht III. Verfassungsrechtliche Grundlagen IV. Europarechtlicher Rahmen V. Ausgewählte Bereiche 1. Baurecht 2. Grundstückverkehrsrecht 3. Wettbewerbsrecht 4. Gewerbeordnung 5. Steuerrecht 6. Sozialrecht	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

Lehrveranstaltung: Agrarverwaltungsrecht (Vorlesung)	2 SWS
Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C

Prüfungsanforderungen: Durch die Modulprüfung weisen die Studierenden nach, dass sie • grundlegende Kenntnisse im Agrarverwaltungsrecht aufweisen,	

• ausgewählte Tatbestände Agrarverwaltungsrechts beherrschen, • die zugehörigen methodischen Grundlagen beherrschen und • systematisch an einen Fall aus dem Agrarverwaltungsrecht herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul S.RW.1276: Agrarrecht vor Gericht** *English title: Agricultural law in court*	6 C 2 SWS
Lernziele/Kompetenzen: Nach erfolgreichem Absolvieren des Moduls „Agrarrecht vor Gericht“ • haben die Studierenden grundlegende Kenntnisse über die einzelnen Rechtswege und die jeweiligen Prozessgrundsätze der im Agrarrecht einschlägigen Gerichtsverfahren erlangt; • haben die Studierenden einen guten Überblick über die im materiellen Agrarrecht auftretenden Fragestellungen (Landpacht, landw. Erbrecht; Grundstücksverkehr; Baurecht ;) • kennen die Studierenden die rechtlichen Tierschutz Grundlagen und Besonderheiten der Verfahren vor den Landwirtschaftsgerichten und anderen agrarrelevanten Gerichten • haben die Studierenden rechtliches Fachwissen und ein Grundverständnis für die ökonomischen und rechtlichen Themen und Problemstellungen in der Agrarwirtschaft anhand von Beispielen und Fällen erlernt; • beherrschen die Studierenden die Fähigkeit, die im agrarischen Kontext auftretenden juristischen Fragen unterschiedlichen Rechtswegen und Verfahrensarten zuzuordnen, sie zu bewerten und zu beantworten. Sie haben ein juristisches und ökonomisches Problembewusstsein im Zusammenhang mit gerichtlichen Verfahren entwickelt sowie die Fähigkeit für juristische Probleme Lösungen zu entwickeln; • sind die Studierenden in der Lage, die erworbenen Kenntnisse bei der Lösung einschlägiger Fälle umzusetzen und sich mit den aufgeworfenen Rechtsfragen kritisch auseinanderzusetzen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden
Lehrveranstaltung: Agrarrecht vor Gericht (Vorlesung) *Angebotshäufigkeit:* jedes Sommersemester	
Prüfung: Mündlich (ca. 15 Min.) oder Klausur (120 Min.) oder Hausarbeit (mind. 10 Seiten).	6 C
Prüfungsanforderungen: • Grundlegende Kenntnisse im Agrarrecht und des agrarrechtlich relevanten Verfahrensrechts aufweisen, • ausgewählte Tatbestände des agrarrechtlich relevanten Zivil- und Verwaltungsverfahrensrechts beherrschen, • die zugehörigen methodischen Grundlagen beherrschen und systematisch an einen agrarrechtlichen Fall agrarrechtlich relevanten Verfahrensrechts herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jose Martinez Soria

Angebotshäufigkeit: 1	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Fakultät für Agrarwissenschaften:

Nach dem Beschluss des Fakultätsrats der Fakultät für Agrarwissenschaften vom 21.12.2023 hat das Präsidium der Georg-August-Universität Göttingen am 31.01.2024 die Neufassung des Modulverzeichnisses zur Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang „Crop Protection" genehmigt (§ 44 Abs. 1 Satz 2 NHG, §§ 37 Abs. 1 Satz 3 Nr. 5 b), 44 Abs. 1 Satz 3 NHG).

Georg-August-Universität
Göttingen

Modulverzeichnis

für den konsekutiven Master-Studiengang "Crop Protection" - zu Anlage 2 der Prüfungs- und Studienordnung für Master-Studiengänge der Fakultät für Agrarwissenschaften (Amtliche Mitteilungen I Nr. 26/2023 S. 856)

Module

Übersicht nach Modulgruppen

I. Master-Studiengang "Crop Protection"

Es müssen Leistungen im Umfang von insgesamt wenigstens 120 C erfolgreich absolviert werden.

The following examination components with a rating of at least 120 C should be successfully completed:

1. Fachstudium

a. Pflichtmodule

Es müssen folgende Pflichtmodule im Umfang von insgesamt 30 C erfolgreich absolviert werden.

The following obligatory modules amounting to a total of 30 C must be completed successfully.

2. Professionalisierungsbereich

a. Wahlpflichtmodule

Es müssen Wahlpflichtmodule im Umfang von insgesamt mindestens 54 C erfolgreich absolviert werden. Ferner können Wahlmodule im Umfang von bis zu 18 C aus den Master-Studiengängen in den Agrarwissenschaften der Universität Göttingen und ein Modul (maximal 6 C) aus dem Masterstudiengang einer anderen Fakultät mit thematischem Bezug zum Studiengang frei gewählt werden.

Elective compulsory modules amounting to a total of at least 54 C must be completed successfully. Up to 18 C in the area of professionalisation can be taken by modules from other master courses of studies in the Agricultural Sciences of the University of Göttingen. In addition, upon request to the examination board, a module amounting to a maximum of 6 C from a master course of study of another faculty may be taken and credited for the area of professionalisation.

b. Schlüsselkompetenzen

Es muss mindestens eins von zwei Wahlpflichtmodulen im Umfang von 6 C erfolgreich absolviert werden.

At least one of two elective compulsory modules amounting to 6 C must be completed successfully.

3. Masterarbeit

Durch die erfolgreiche Anfertigung der Masterarbeit werden 24 C erworben.

24 C are awarded for successful completion of the master thesis.

4. Kolloquium zur Masterarbeit

Durch das erfolgreiche Absolvieren des Kolloquiums zur Master-Arbeit werden 6 C erworben.

6 C are awarded for successful completion of the colloquium on the master thesis.

II. Double/Joint-Degree Programm "PlantHealth"

1. Erstes Studienjahr

Es müssen Leistungen im Umfang von insgesamt wenigstens 60 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

Modules with a rating of at least 60 credits in total should be successfully completed in accordance with the following provisions.

a. Pflichtmodule

Es müssen folgende Module im Umfang von insgesamt 27 C erfolgreich absolviert werden:

The following modules with a rating of 27 C in total must be successfully completed:

b. Wahlpflichtmodule

Es müssen wenigstens vier der folgenden Module im Umfang von insgesamt wenigstens 27 C erfolgreich absolviert werden:

At least four of the following modules amounting to a total of at least 27 C must be completed successfully:

c. Schlüsselkompetenzen

Es müssen Module aus dem zulässigen Angebot des Kompetenzbereichs Sprachkenntnisse im Umfang von insgesamt wenigstens 6 C erfolgreich absolviert werden.

Modules from the permitted range of the competence area language skills amounting to a total of at least 6 C must be completed successfully.

2. Zweites Studienjahr

Es müssen Leistungen im Umfang von insgesamt wenigstens 60 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

Modules with a rating of at least 60 credits in total should be successfully completed in accordance with the following provisions.

a. Pflichtmodul

Es muss das folgende Modul im Umfang von 6 C erfolgreich absolviert werden:

The following module with a rating of 6 C must be successfully completed:

b. Wahlpflichtmodule

Es müssen vier der folgenden Module im Umfang von insgesamt 24 C erfolgreich absolviert werden:

Four of the following modules amounting to 24 C in total have to be completed successfully:

c. Masterarbeit

Durch die erfolgreiche Anfertigung der Masterarbeit werden 24 C erworben.

24 C are awarded for successful completion of the master thesis.

d. Kolloquium zur Masterarbeit

Durch das erfolgreiche Absolvieren des Kolloquiums zur Masterarbeit werden 6 C erworben.

By successfully completing the colloquium on the master thesis, 6 C will be acquired.

Georg-August-Universität Göttingen **Module M.Agr.0003: Agribusiness Sugar Beet- an advanced education for graduate students and junior employees of the sugar supply chain (English)**	6 C
Learning outcome, core skills: • profound knowledge in the following fields of the sugar value chain: breeding and other upstream sectors, technology of the sugar and bioethanol industry and biogas production, other downstream sectors, sugar market, agricultural policy • detailed identification of causal relationships in the process management on the basis of recent scientific knowledge • knowledge enhancement by interpreting scientific figures and tables and their statistics • opportunity of an advanced education particularly suitable as an on-the-job training program • opportunity to develop a professional network with other graduate students and external participants from different professional backgrounds and sugar beet growing areas worldwide	**Workload:** Attendance time: 54 h Self-study time: 126 h
Course: Agribusiness Sugar Beet - an advanced education for graduate students and junior employees of the sugar supply chain (English) (Block course, Lecture, Excursion) *Contents*: In comparison to other cash crops the refining of sugar from sugar beet is characterized by a considerable degree of cooperation between agriculture and food industry. Consequently all specific impacts of the entire production chain of sugar from beet are covered by this module as there are plant breeding, soil cultivation, growing impacts from sowing to harvest including all technical and cultivation aspects, crop yield, extension services, weed control, pathogen and pest management, precision agriculture, as well as definition and analysis of the technical quality, processing technology of sugar beets, logistics of harvest and transportation, global trade, sugar as food and its marketing. The module consists of lectures by invited speakers and lecturers of the Institute of Sugar Beet Research, work shops, field trips and excursion.	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Knowledge of the sugar value chain and understanding of different influences on the system on the basis of the latest scientific insights.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Anne-Katrin Mahlein
Course frequency: each summer semester	**Duration:** 2 Weeks

Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen Module M.Agr.0009: Biological Control and Biodiversity	6 C 6 WLH
Learning outcome, core skills: Gain an understanding of what biological control is and how it can be used effectivelyas part of an IPM system and how biodiversity contributes to control of pest populations and other ecosystem services.	**Workload:** Attendance time: 84 h Self-study time: 96 h

Course: Biological Control and Biodiversity (Lecture, Exercise, Seminar) *Contents*: • Theoretical foundations of biological control • Natural enemy behaviour and biological control success • Biodiversity and ecosystem services in agroecosystems • Practical examples of biological control projects • Plant-herbivore-predator-interactionsPrinciples of population dynamics • Biological weed control	6 WLH
Examination: Written exam (70%; 45 minutes) and presentation (30%; approx. 20 minutes) **Examination prerequisites:** Regular attendance at seminar and exercise and presentation of a seminar talk **Examination requirements:** Basic knowledge of the mechanisms of biological control of herbivorous insects; methodological approaches based on case examples; role of biodiversity for ecosystem processes and the population dynamic of herbivorous insects, multitrophic interactions between plants, herbivorous insects and their natural enemies; biodiversity and services of ecosystems.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Michael Georg Rostás
Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 12	

Georg-August-Universität Göttingen **Modul M.Agr.0010: Biotechnological Applications in Plant Breeding** *English title: Biotechnological Applications in Plant Breeding*	6 C 4 SWS
Lernziele/Kompetenzen: Studierende erlernen Kenntnisse über biotechnologische Methoden selbständig auf aktuelle Probleme anzuwenden und Lösungswege zu entwickeln. Sie lernen komplexe wissenschaftliche Texte zu analysieren, aufzuarbeiten und in verständlicher Form an Dritte weiterzugeben	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Biotechnological Applications in Plant Breeding (Blockveranstaltung, Praktikum, Vorlesung, Seminar) *Inhalte*: Die Studenten erwerben in diesem Modul vertiefte theoretische und praktische Kenntnisse über biotechnologische und molekulargenetische Methoden in der Pflanzenzüchtung. Im Rahmen der studentischen Seminare werden dazu aktuelle Anwendungen in der Pflanzenzüchtung und der Landwirtschaft vorgestellt und deren Auswirkungen kritisch diskutiert. Zentrale theoretische und praktische Inhalte sind die Anwendung der schnellen In-vitro-Vermehrung, Erzeugung und Nutzung von Haploiden, interspezifische sexuelle und somatische Hybridisierung, direkter und indirekter Gentransfer, biochemische und molekulare Charakterisierung transgener Pflanzen, aktuelle Anwendungen in der Gentechnik und Risikobeurteilung, Eigenschaften und Anwendung verschiedener molekularer Markertypen in der Pflanzenzüchtung.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Vertiefte und komplexe theoretische Kenntnisse über die wichtigsten biotechnologischen Methoden und Anwendungen in der Pflanzenzüchtung	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Christian Möllers
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 12	

Georg-August-Universität Göttingen **Modul M.Agr.0023: Interactions between plants and pathogens** *English title: Interactions between Plants and Pathogens*	6 C 4 SWS

Lernziele/Kompetenzen: Kenntnisse komplexer Wechselwirkungen zwischen Pflanzen und Pathogenen. Ableitung wissenschaftlicher Fragestellungen und kritische Bewertung von angewendeten Methoden unterstützt durch eigene praktische Labortätigkeit.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Interaktionen zwischen Pflanzen und phytopathogenen Organismen sowie Viren (Praktikum, Vorlesung) *Inhalte*: Das Modul beschäftigt sich mit der Wechselwirkung von Pflanzen mit phytopathogenen Pilzen, Bakterien und Viren. Hierbei werden pilzliche, bakterielle und virale Aspekte der Infektionslehre behandelt. In diesem Rahmen wird die Sporenkeimung, das Eindringen und die Ausbreitung der Pathogene (incl. Virusreplikation und –verbreitung) in der Wirtspflanze dargestellt. An die Infektionslehre folgt die Beschreibung pflanzlicher Resistenzfaktoren (präformierte und induzierte), deren Bedeutung sowie pathogenseitige Möglichkeiten der Inaktivierung. Als weitere Inhalte des Moduls werden Phänome, wie die induzierte und/oder systemisch erworbene Resistenz (SAR) beschrieben. Detailiert wird auf das Pathosystem Agrobacterium tumefaciens / dikotyle Pflanzen eingegangen. An konkreten Beispielen wird die Gen-für-Gen Hypothese und ihr experimenteller Nachweis erläutert. Hierbei wird kurz und beispielhaft auf bekannte Resistenzgene eingegangen. Im Rahmen des praktischen Teils werden von den Studierenden Phytoalexinextraktionen aus Raps vorgenommen sowie analytische Verfahren zu deren Nachweis und biologischen Wirksamkeit mittels chromatografischer Techniken (HPLC bzw. TLC-Bioassay) durchgeführt.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Teilnahme am praktischen Teil des Moduls im Anschluss an die Vorlesung und Anfertigung eines von den Prüfenden inhaltlich akzeptierten Protokoll **Prüfungsanforderungen:** Profunde Kenntnisse von Infektionsvorgängen bei Viren, Bakterien und Pilzen, von Mechanismen der Wirtserschließung, Pathogenerkennung, Signaltransduktion, präformierter und induzierter Resistenzmechanismen sowie der Gen-für-Gen Hypothese	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Birger Koopmann
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 36	

Georg-August-Universität Göttingen **Modul M.Agr.0039: Molecular Techniques in Phytopathology** *English title: Molecular Techniques in Phytopathology*	6 C 4 SWS
Lernziele/Kompetenzen: Methodische Kenntnisse im Umgang mit Nukleinsäuren, Ableitung von methodischen Lösungsansätzen für eigene wissenschaftliche Fragestellungen. Präsentation von Ergebnissen und grundlegenden Methodenkenntnissen sowie Ergebnisinterpretation im Rahmen einer Abschlussbesprechung.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Molecular Techniques in Phytopathology (Praktikum, Vorlesung) *Inhalte*: Im Rahmen dieses Praktikums werden mit Hilfe von Experimenten grundlegende molekularbiologische Techniken vermittelt: Isolierung von Plasmiden und Gesamt-DNA sowie DNA-Fragmenten aus Agarosegelen, Restriktionsanalyse, Agarose-Gelektrophorese, Klonierung von PCR-Produkten (enzymatische Modifikation, Ligation),Transformation und in vivo Amplifikation von Plasmiden, DNA Blotting, Markierung von DNA-Sonden mit nicht-radioaktiven Methoden (DIG-dUTP), Southern-Hybridisierung und immunologische Detektion von hybridisierten Sonden mit Chemolumineszenzsubstraten, ITS-RFLP-Analysen bei pilzlichen Rapspathogenen, Real-time PCR-Diagnostik von mykotoxinbildenden pilzlichen Getreidepathogenen. In dem begleitenden Vorlesungsteil werden grundlegende und anwendungs-bezogene nukleinsäurechemische und proteinchemische Kenntnisse vermittelt, die zum Verständnis nicht nur der vorgestellten Techniken notwendig sind. Zudem werden in einem anwendungsbezogenen Teil Lösungsansätze für bestimmte wissenschaftliche Fragestellungen dargelegt und diskutiert.	4 SWS
Prüfung: Mündlich (ca. 30 Minuten) **Prüfungsvorleistungen:** Anfertigung eines für den Prüfenden akzeptierten Praktikumsprotokolles **Prüfungsanforderungen:** Grundlegende Kenntnisse über den Aufbau von Nukleinsäuren, von Enzymen und deren Einsatz in molekular-biologischen Experimenten, von Standardanalyseverfahren (Southern Blot, PCR, Elektrophorese, DNA-Sequenzierung), der Analyse multivariater Daten sowie dem Einsatz verschiedener Verfahren für wissenschaftliche Fragestellungen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Birger Koopmann
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 16	

Georg-August-Universität Göttingen **Modul M.Agr.0045: Mycology** *English title: Mycology*	6 C 4 SWS
Lernziele/Kompetenzen: Umgang mit und Erkennung von phytopathogenen Pilzen. Experimentelles Arbeiten im Rahmen verschiedener phytopathologischer Fragestellungen. Gruppenarbeiten mit Übernahme von Sprecherfunktion, Auswertung und Darstellung von Versuchsergebnissen in einer englischsprachigen Präsentation	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Mycology (Praktikum, Vorlesung) *Inhalte*: Überblick über die Ökologie und Taxonomie phytopathologisch relevanter Pilze. Übungen zur taxonomischen Klassifizierung anhand morphologischer Merkmale an Reinkulturen, Durchführung von Versuchen zur Pilzisolierung, Antagonistengewinnung, Nachweis natürlicher Fungistatis im Boden, Saatgutdesinfektion, in situ Studien zur Pathogenese von biotrophen und nekrotrophen Pilzen, Rassenbestimmungen beim Echten Mehltau, Untersuchungen zur Fungizidresistenz.	4 SWS
Prüfung: Mündlich (ca. 20 Minuten) **Prüfungsvorleistungen:** Gruppenprotokoll und Ergebnispräsentation **Prüfungsanforderungen:** Grundlagenkenntnisse in Pilztaxonomie, Lebenszyklen, ökologischer Ansprüche, diagnostischer Merkmale, Krankheiten und pflanzenassozierte Strukturen, Abwehrmechanismen und Methoden	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Andreas von Tiedemann
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 1
Maximale Studierendenzahl: 12	

Georg-August-Universität Göttingen **Modul M.Agr.0056: Plant breeding methodology and genetic resources** *English title: Plant Breeding Methodology and Genetic Resources*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen, klassische und molekulare Methoden und Techniken bei der Lösung pflanzenzüchterischer Problemen zu integrieren. Sie lernen, eigene Schlussfolgerungen aus klassischen und neuesten Veröffentlichungen zu ziehen und diese Wissenschaftlern und Studierenden verständlich, knapp und klar zu vermitteln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Plant breeding methodology and genetic resources (Vorlesung) *Inhalte*: Grundlagen der Zuchtmethodik: Populationsgenetik, Zuchtmethoden in der Klon-, Linien-, Hybrid- und Populationszüchtung, Marker-gestützte Selektion für monogene und polygene Merkmale. Nutzung pflanzengenetischer Ressourcen: Wildarten, ex-situ und in-situ-Erhaltung, on-farm-Management. Züchtung für marginale Standorte mit Beispielen aus gemäßigten und tropischen Breiten. Dieses Modul und das Modul "Genetic Principles of Plant Breeding" ergänzen sich wechselseitig.	4 SWS
Prüfung: Klausur (Gewicht: 80%, Dauer: 90 Minuten) und Präsentation, Referat oder Korreferat (Gewicht: 20%, Dauer: ca. 20 Minuten) **Prüfungsanforderungen:** Grundlagen zu: Populationsgenetik, Einsatz von Markern in der Pflanzenzüchtung, Konzepte zur Nutzung Pflanzengenetischen Ressourcen. Gute Kenntnisse: 'Pre-Breeding', Kategorien und Methoden der Pflanzenzüchtung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** apl. Prof. Dr. Wolfgang Link
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Module M.Agr.0057: Plant Virology**	6 C 6 WLH

Learning outcome, core skills: Knowledge in classical and molecular Plant Virology, Learning of practical plant virus detection methods with electron-optical methods, immunological methods. Deduction of scientific questions and hypotheses and critical review of methods applied based on personal lab experience.	**Workload:** Attendance time: 80 h Self-study time: 100 h

Course: Plant Virology (Internship, Lecture) *Contents*: Lecture: systematics, vectors, modes of transmission, genome organisation, gene expression strategies, control strategies Practical course: learning of diagnostic methods, symptom recognition, immunogical and molecular detection methods	6 WLH
Examination: Written exam (45 minutes, weighing 50%) and term paper (max. 20 pages, weighing 50%) **Examination prerequisites:** Regular participation at the practical course following the lecture **Examination requirements:** Understanding of the imparted detection methods and knowledge about virus biology.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Mark Varrelmann
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 16	

Georg-August-Universität Göttingen **Modul M.Agr.0058: Plant herbivore interactions** *English title: Plant-Herbivore Interactions*	6 C 4 SWS
Lernziele/Kompetenzen: Kenntnisse komplexer Wechselwirkungen zwischen Pflanzen und herbivoren Insekten. Ableitung wissenschaftlicher Fragestellungen und kritische Bewertung von angewendeten Methoden durch Erarbeitung eines eigenen Seminarbeitrages zu aktuellen Forschungsergebnissen.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
Lehrveranstaltung: Plant herbivore interactions (Vorlesung, Seminar) *Inhalte*: Das Modul beschäftigt sich mit der Wechselwirkung zwischen Pflanzen und herbivoren Insekten. Die Diversität der beteiligten Organismen und der Lebensgemeischaften werden dargestellt. Auf der Seite der Pflanzen werden die verschiedenen Abwehrstrategien unter Einschluss der Resistenzmechanismen gegenüber Fraßfeinden exemplarisch vorgestellt. Die sensorischen Ausstattungen der herbivoren Insekten zur Erkennung der Pflanzen werden beschrieben. Multiple Interaktionen zwischen Pflanzen, Fraßfeinden und natürlichen Gegenspielern sowie die Anwendungsmöglichkeiten werden diskutiert. Schließlich werden die Wechselbeziehungen zwischen Pflanzen und blütenbestäubenden bzw. blütenbesuchenden Insekten behandelt. Im Rahmen des Semiarteils werden von den Studierenden jeweils aktuelle Forschungsergebnisse vorgestellt und im Zusammenhang mit den in den Vorlesungen behandelten Themen diskutiert.	4 SWS
Prüfung: Klausur (Gewicht: 67%, Dauer: 45 Minuten) und Präsentation, Referat oder Korreferat (Gewicht: 33%, Dauer: ca. 20 Minuten) **Prüfungsvorleistungen:** Teilnahme an den Seminaren und Bearbeitung und Vorstellung eines Seminarbeitrages **Prüfungsanforderungen:** Umfassende Kenntnisse der wesentlichen Faktoren der Wirtspflanzenwahl herbivorer Insekten, Abwehrstrategien der Pflanzen, Determinanten für herbivore Lebensgemeinschaften an spezifischen Pflanzen, multitrophische Interaktionen zwischen Pflanzen, herbivoren Insekten und Gegenspielern; Wechselbeziehungen zwischen Pflanzen und Bestäubern.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Michael Georg Rostás
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

20	

Georg-August-Universität Göttingen **Modul M.Agr.0094: Basics of Molecular Biology in Crop Protection** *English title: Basics of Molecular Biology in Crop Protection*	6 C 4 SWS

Lernziele/Kompetenzen: Verständnis der Grundlagen wichtiger agrarwissenschaftlicher Untersuchungsmethoden wie ELISA und PCR, Verständis der biochemischen und molekularbiogischen Grundlagen von Züchtung und pflanzlicher Resistenzen gegen Schaderreger.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Grundlagen und Anwendung der Molekularbiologie in der Phytomedizin (Vorlesung) *Inhalte*: In der landwirtschaftlichen Forschung und Diagnostik werden vermehrt biochemische und molekularbiologische Methoden verwendet. Die Vorlesung vermittelt die Grundlagen, die zum Verständnis dieser Methoden notwendig sind, und bereitet auf weiterführende Praktika und Vorlesungen vor. Inhalte sind: Cytologie, Aufbau der Zellwände verschiedener Organismengruppen, Struktur und Funktion von Makromolekülen (Proteine, DNA, RNA, Kohlenhydrate), Funktion und Regulation von Enzymen, DNA-Replikation, Transkription und Translation, Regulationsmechanismen, Einführung in das Prinzip grundlegender molekularer Nachweismethoden, Lipide und Membranen, Phytohormone, ausgewählte Sekundärstoffe.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Aufbau von Makromolekülen, Ausgangsstoffe, typische Bindungstypen, Funktion, Bedeutung, Regulationsmechanismen auf Protein- und Nukleinsäureebene, Phytohormone, Sekundärstoffwechsel	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Anke Sirrenberg
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Module M.Agr.0120: Molecular Diagnostic and Biotechnology in Crop Protection**	6 C 4 WLH

Learning outcome, core skills: Participants will be able to understand nucleic acid based as well as immunologic diagnostic tools for detection of plant pathogens and pests. More the ability to select appropriate diagnostic techniques and make informed decisions regarding their development and application is one of the core skills. Students shall understand the role of biotechnology in plant protection and resistance breeding to be able to assess the potentials and risks of GM crops and other GMOs in plant protection.	**Workload:** Attendance time: 65 h Self-study time: 115 h

Course: Molecular Diagnostic and Biotechnology in Crop Protection (Lecture) *Contents*: Principles and applications of diagnostic techniques in plant protection with a focus on nucleic acid analysis (characteristics as accuracy, detection level, multiplexing, quantification, portability, and designability). Nucleic acid detection: RT-PCR viruses, group specific primers, multiplex dsRNA-diagnosis (viruses), qPCR (SYBR, TaqMan, fluorophores), Nested-PCR, RFLP, MLSA, ddPCR (phytoplasma), Barcoding (fungi, insects, weeds) SNP-genotyping (KASP, etc.), RCA (DNA viruses, Padlock-probes), Hybridisation (dot-blot viruses, RNAscope, SABER-FISH), DNA-arrays (microarrays), HTS/NGS/Transcriptomics (Virome/metagenomics analysis, discovery of new virus diseases), Sequencing platforms (Roche 454, Illumina, Solid and Ion Torrent, SMRT and MinION nanopore sequencing), Isothermal amplification techniques (LAMP, RPA, HAD, NASBA), CRISPR based diagnosis (viruses) Molecular detection of specific traits (fungicide, herbicide, insecticide resistance). Protein detection: ELISA, TPIA, LFA, Immune fluorescence, ISEM electron microscopy, confocal microscopy and fluorescent labelled viruses, Immuno(capture)-PCR, Luminex. Biotechnology in plant protection: Crop trait targets, techniques to increase genetic diversity, cisgenesis, NGS and third generation sequencing, omics, genetically modified organisms (GMOs) in engineering resistance to viruses, pests, herbicides, bacterial and fungal pathogens, genome editing tools, applications of RNA interference and epigenome modifications, RNAi machinery, cross-kingdom RNAi, VIGS, HIGS, SIGS, Epigenetics, regulation and public acceptance, risk assessment	4 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Understanding concepts and technical principles of molecular diganostic methods and the applicatoin of molecular markers and plant biotechnology in plant protection. Demonstration of the ability to read primary literature that describes applications of techniques covered by the module	6 C

Admission requirements:	**Recommended previous knowledge:**
none	none

Language: English	**Person responsible for module:** Prof. Dr. Mark Varrelmann
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Georg-August-Universität Göttingen Module M.Agr.0173: Nematology	3 C 2 WLH
Learning outcome, core skills: Basic knowledge of nematode biology, importance as pests; basic methods with regard to their detection, identification and measures of control, use of beneficial nematodes in biological insect control programs; their role in regulation of processes in ecosystems.	**Workload:** Attendance time: 40 h Self-study time: 50 h
Course: Nematology (Praktikum, Seminar) *Contents*: The module deals with the biology of nematodes and their importance in plant protection. The most important taxa of nematodes are presented using permanent slides and living specimen; the most important morphological characters will be identified. Interactions between plant parasitic nematodes, their host plants and antagonistic microorganisms will be discussed. The use of nematodes for innundative biological control will be discussed as well. During the course, students will become familiar with different plant parasitic nematode species and will learn basic techniques for detection and identification. Plant parasitic nematodes will be used to demonstrate effects of different compounds on activity and viability.	
Examination: Written examination (45 minutes) **Examination requirements:** Basic knowledge of morphological characters of nematodes; species identification by DNA-barcoding ability to discriminate between different feeding types of nematodes; biological control of and biological control with nematodes; importance of nematodes for biodiversity	3 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of molecular diagnostics
Language: English	**Person responsible for module:** Dr. Birger Koopmann
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 3
Maximum number of students: 12	

Georg-August-Universität Göttingen **Module M.Agr.0174: Plant Health Management in Tropical Crops**	6 C 4 WLH
Learning outcome, core skills: Students are able to recognize pests and diseases of tropical crops as treated in this course. They critically evaluate scientific and non-scientific publications on crop protection in the tropics. Students are able to create a scientific presentation according to the standards of international conferences and use interactive teaching material; students know the scope and limits of their knowledge in the treated field, they know where to find relevant, reliable information. Students learn to consider subject-related issues from a variety of different perspectives and to work effectively in international teams.	**Workload:** Attendance time: 36 h Self-study time: 144 h

Course: Plant Health Management in Tropical Crops (Lecture, Excursion, Seminar) *Contents*: Blended learning module; presentation of the most important pests and diseases of the most important tropical crop plants: symptoms, life cycles and plant health management (eg. in rice, maize, cacao, coffee, bananas). Additional crops may be included according to students´ preferences and practical experience. Introduction to relevant international data banks and networks. Use of scientific videos on selected topics of crop protection in the tropics.	4 WLH
Examination: Written exam (45 min, 40%), Student presentation with discussion (ca. 20 min presentation + ca. 10 min discussion 60%) **Examination requirements:** • Written exam: main groups of causal agents, basic botany of the crop plants treated, basic biology of causal agents (life cycles etc.), recognition of symptoms, knowledge of control strategies. • Presentation: appropriate according to the standard of international conferences: relevant and sound content, clear structure, style, language (written and spoken) and pronunciation, citation and use of sources according to good scientific practice.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basics of plant pathology, including basics of integrated pest management
Language: English	**Person responsible for module:** Prof. Dr. Michael Georg Rostás
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 2
Maximum number of students: 30	

Additional notes and regulations:

The module is designed as a blended learning-course with strong emphasis on digital material and student based learning. Contact time is reduced to allow thorough preparation of the presentations.

Georg-August-Universität Göttingen **Modul M.Agr.0175: Plant-Herbivore Interactions (Experimental course)** *English title: Plant-Herbivore Interactions (Experimental course)*	3 C 2 SWS
Lernziele/Kompetenzen: Die Studierenden werden die Fähigkeit erlernen, Experimente zu planen, durchzuführen, statistisch auszuwerten, grafisch darzustellen und zu interpretieren. Sie werden in der Lage sein, Sekundärmetaboliten mit Abwehr- oder Signalfunktion aus der Pflanze zu isolieren und zu quantifizieren. Die Studierenden erlernen die Durchführung von Bioassays, welche die Abwehrfunktion der Sekundärmetaboliten nachweisen sollen.	**Arbeitsaufwand:** Präsenzzeit: 40 Stunden Selbststudium: 50 Stunden
Lehrveranstaltung: Plant-Herbivore Interactions (Experimental course) (Übung, Seminar) *Inhalte*: Das Modul ergänzt die gleichnamige Vorlesung und beschäftigt sich mit den Wechselwirkungen zwischen (Nutz)Pflanzen und herbivoren Insekten. Im Praktikum sollen die in der Vorlesung erworbenen Kenntnisse vertieft und Methoden der chemischen Ökologie / Agrarentomologie erlernt werden. Insbesondere werden verschiedene Abwehrstrategien der Pflanze gegenüber Fraßfeinden untersucht. Die Bedeutung von Prädatoren und Parasitoiden für die Populationskontrolle von herbivoren Schädlingen, und somit für den integrierten Pflanzenschutz, werden behandelt. Literatur: Schoonhoven et al. (2005) Insect-Plant Biology, 2nd Ed., Oxford University Press	2 SWS
Prüfung: Protokoll über die durchgeführten Experimente (max. 15 Seiten) **Prüfungsanforderungen:** Dokumentation und Interpretation der durchgeführten Versuche entsprechend dem wissenschaftlichen Standard. Seminarvortrag	3 C

Zugangsvoraussetzungen: An „M.Agr.0058.Mp: Plant-Herbivore Interactions” erfolgreich teilgenommen.	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Michael Georg Rostás
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Woche
Wiederholbarkeit: einmalig	**Empfohlenes Fachsemester:** ab 2
Maximale Studierendenzahl: 12	

Georg-August-Universität Göttingen **Modul M.Cp.0002: Internship** *English title: Internship*	9 C 6 SWS
Lernziele/Kompetenzen: Fachbezogene Kenntnisse des jeweiligen Arbeitgebietes, soziale Kompetenzen (Arbeitsorganisation, Teamarbeit, Interdisziplinäres Arbeiten, Flexibilität), praktisch methodische Kompetenzen.	**Arbeitsaufwand:** Präsenzzeit: 240 Stunden Selbststudium: 30 Stunden
Lehrveranstaltung: Internship (Praktikum) *Inhalte*: Praktische Mitarbeit in unterschiedlichen Bereichen des Pflanzenschutzes, Industrie, Ressortforschung, Beratung. Einblick in Arbeitsmethoden, Aufgaben, Berufsalltag im Pflanzenschutz. Erwerb praktisch-anwendungsbezogener Kenntnisse. Praktikumsdauer: 6 Wochen	6 SWS
Prüfung: Seminararbeit (max. 20 Seiten, Gewichtung: 50%) und Präsentation, Referat oder Korreferat (ca. 20 Minuten, Gewichtung: 50%) **Prüfungsanforderungen:** Praktische Mitarbeit in unterschiedlichen Bereichen des Pflanzenschutzes, Praktikumsbericht und Präsentation	9 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Andreas von Tiedemann
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 3
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Cp.0004: Plant Diseases and Pests in Temperate Climate Zones** *English title: Plant diseases and pests in temperate climate zones*	6 C 4 SWS

Lernziele/Kompetenzen: Kenntnis and Diagnose von Krankheiten und tierischen Schädlingen an Kulturpflanzen. Verständnis der Entstehung, Verbreitung und Dynamik von Schaderregern im Feld als Grundlage für die Entwicklung von Bekämpfungsmaßnahmen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Plant Diseases and Pests in Temperate Climate Zones (Vorlesung, Exkursion, Übung) *Inhalte*: Es werden die in gemäßigten Zonen an Kulturpflanzen auftretenden, wichtigsten Schadorganismen (Viren, Bakterien, Pilze, Nematoden, Milben, Insekten, u.a.) eingehend behandelt. Neben der Erkennung und Diagnose der Schadorganismen und der typischen Befallssymptome stehen die wirtschaftliche Bedeutung, die Biologie, die Prognose und die verschiedenen Möglichkeiten der Bekämpfung, insbesondere unter Beachtung von Bekämpfungs- und Schadensschwellen, im Vordergrund.	4 SWS
Prüfung: Klausur (45 Minuten) **Prüfungsvorleistungen:** Teilnahme an Exkursionen und Übungen im Feld **Prüfungsanforderungen:** Kenntnis und Diagnose von Pflanzenkrankheiten und tierischen Schädlingen an Kulturpflanzen des gemäßigten Klimas, ihrer Entwicklungs- und Lebenszyklen im Feld.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Birger Koopmann
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 2
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Cp.0005: Integrated Management of Pests and Diseases** *English title: Integrated management of pests and diseases*	6 C 4 SWS
Lernziele/Kompetenzen: Verstehen und gestalten von Pflanzenschutzstrategien gegen pathogene und Schädlinge im Gesamtkonzept des Anbausystems.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Integrated Management of Pests and Diseases (Vorlesung) *Inhalte*: Erläuterung des Konzeptes des Integrierten Pflanzenschutzes (IPS) und Behandlung seiner wichtigsten Elemente in Bezug auf die Bekämpfung von pilzlichen Pathogenen (A. v. Tiedemann) und Schadinsekten (B. Ulber) in den gemäßigten Breiten: vorbeugende Maßnahmen, gezielter Einsatz von Pflanzenschutzmitteln; Auswirkungen von Anbaufaktoren und –systemen (Bodenbearbeitung, Aussaattermin, Düngung, Fruchtfolge, Sorte) auf Auftreten, Verbreitung und Schadwirkung von Pathogenen und Schädlingen; Diagnostik u. Quantifizierung von Befall; Prognosesysteme	4 SWS
Prüfung: Mündlich (ca. 20 Minuten) **Prüfungsanforderungen:** Kenntnisse der Auswirkungen von Anbaufaktoren u. Anbausystemen auf das Auftreten von Krankheiten und Schädlingen in gemäßigten Breiten.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Andreas von Tiedemann
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 1
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Cp.0006: Pesticides I: Mode of Action and Application Techniques, Resistance to Pesticides** *English title: Pesticides I: Mode of action and application techniques, resistance to pesticides*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen Kenntnisse zu Pflanzenschutzmitteln insbesondere deren Wirkungsweise, Anwendungstechniken. Sie verstehen die Entwicklung von Resistenz gegen Pestizide und Möglichkeiten diese zu verzögern oder zu umgehen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Pesticides I: Mode of Action and Application Techniques, Resistance to Pesticides (Vorlesung, Exkursion) *Inhalte*: In dem Modul werden Wirkungen und Anwendungsverfahren chemischer Pflanzenschutzmittel (Funigizide, Insektizide, Akarizide, Herbizide) vorgestellt und die wichtigsten Wirkstoffgruppen besprochen. Technische und technologische Voraussetzungen moderner Pflanzenschutzverfahren, Applikationstechniken werden vorgestellt. Entwicklung von Resistenz gegen Pestizide wird dargestellt	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Kenntnisse von Einsatzbereichen, Wirkungsweisen(targets) Nebenwirkungen (side effects) von Pflanzenschutzmitteln; Applikationsverfahren; Faktoren der Resistenzentwicklung und ihrer Vermeidung.	6 C

Zugangsvoraussetzungen: Eingeschrieben im Studiengang Crop Protection	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Andreas von Tiedemann
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 1
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Module M.Cp.0007: Pesticides II: Toxicology, Ecotoxicology, Environmental Metabolism, Regulation and Registration**	6 C 4 WLH

Learning outcome, core skills: Students will understand the basic and applied pesticide toxicology and ecotoxicology, the development of pesticides and risk assessment, and the regularory framework of pesticide registration and pesticide risks (Germany, EU)	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Pesticides II: Toxicology, Ecotoxicology, Environmental Metabolism, Regulation and Registration (Lecture) *Contents*: This unique module gives an overview of all aspects of pesticide science, presented by Several lecturers, being specialists. Basic and applied toxicology of pesticides , ecotoxicology of pesticides, environmental fate and metabolism of compounds in different environments, development of pesticides, regulation of pesticide use and registration.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Knowledge of the toxicology of pesticides, ecotoxicology, fate and metabolism in the environment, regulation and registration of pesticides in Germany and the EU.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Andreas von Tiedemann
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 3
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul M.Cp.0008: Fungal Toxins** *English title: Fungal toxins*	6 C 4 SWS

Lernziele/Kompetenzen: Die Teilnehmer werden für die Bedeutung von Sekundärmetaboliten von Pilzen in der Pflanzenproduktion sensibilisiert. Sie werden in die Lage versetzt, eine vergleichende Bewertung der Relevanz von natürlichen Toxinen und anthropogenen Stoffen durchzuführen und die verschiedener Lebensmittelkontaminanten toxikologisch einzuordnen. Im Laborteil werden sie praktische Kenntnisse von chemisch-analytischen Verfahren erwerben, die es ihnen ermöglichen, für konkrete Aufgaben in ihrem Beruf die optimale analytische Methode zu wählen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Fungal Toxins (Vorlesung, Laborpraktikum) *Inhalte*: Es werden die für die Praxis wichtigsten Mykotoxine vorgestellt, Konzepte der Toxizitätsbestimmung erläutert, Verfahren für die Ableitung von gesetzlichen Limits erklärt und das von den Mykotoxinen ausgehende Risiko für die Gesundheit von Verbrauchern und Nutztieren bewertet. Die ökologischen Funktionen von Mykotoxinen werden diskutiert, Methoden für die Mykotoxinbestimmung erklärt und Verfahren zur Reduktion der Mykotoxinbelastung bei Pflanzenprodukten erläutert. Ausgewählte Phytotoxine und Phytohormone werden vorgestellt, die als Virulenz- oder Pathogenitätsfaktoren an der Ätiologie von Pflanzenkrankheiten beteiligt sind. Im praktischen Teil werden die Modulteilnehmer die Aufbereitung von Pflanzenmaterial durchführen und ausgewählte Methoden für die Mykotoxinbestimmung anwenden.	4 SWS
Prüfung: Klausur (60 Minuten) **Prüfungsvorleistungen:** Voraussetzung ist angenommenes Protokoll vom Praktikum **Prüfungsanforderungen:** Die wichtigsten Mykotoxine in der Pflanzenproduktion; Methoden der Toxizitätsbestimmung, Ableitung von gesetzlichen Limits; ökologische Funktionen von Mykotoxinen; Methoden für die Mykotoxinbestimmung; Einflussgrößen auf die Mykotoxinbelastung von Pflanzenprodukten; die Rolle von Phytotoxinen und Phytohormonen als Virulenz- und Pathogenitätsfaktoren.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. M. Alhussein
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

12	

Georg-August-Universität Göttingen **Modul M.Cp.0010: Plant Pathology and Plant Protection Seminar** *English title: Plant Pathology and Plant Protection seminar*	3 C 2 SWS
Lernziele/Kompetenzen: Präsentation eines eigenen wissenschaftlichen Projektes und dessen Verteidigung im Rahmen einer Diskussion in englischer Sprache. Fachlich kritische und konstruktive Diskussion fremder Ergebnisse	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden
Lehrveranstaltung: Plant Pathology and Plant Protection Seminar (Seminar) *Inhalte*: Im Rahmen dieser Veranstaltung werden Projekte, Projektziele und - Ergebnisse einem kritischen, wissenschaftlichen Publikum in englischer Sprache vorgestellt und von den Masterstudenten sowie wissenschaftlichen Mitarbeitern diskutiert. Hierbei sollen nicht nur Präsentationstechnik und Diskussionsfähigkeit trainiert werden, sondern im Rahmen der Diskussion auch Anregungen für weiterführende Arbeiten gegeben werden.	2 SWS
Prüfung: Präsentation, Referat oder Korreferat (ca. 20 Minuten) **Prüfungsvorleistungen:** Teilnahme an 12 Seminaren **Prüfungsanforderungen:** Kenntnisse des eigenen Forschungsgebietes und der entsprechenden Präsentationsanforderungen. PC-Präsentation eigener Ergebnisse in englischer Sprache, Teilnahme und Diskussion	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Birger Koopmann
Angebotshäufigkeit: jedes Semester	**Dauer:** 2 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** ab 2
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Cp.0011: Agricultural Entomology Seminar** *English title: Agricultural entomology seminar*	3 C 2 SWS

Lernziele/Kompetenzen: Die Studierenden erlangen hierbei die Kompetenz, Forschungsergebnisse aufzubereiten, vorzutragen und in einer fachübergreifenden Diskussion zu verteidigen. Fachlich kritische und konstruktive Diskussion fremder Ergebnisse. *Students will acquire skills in evaluating and defending their own research in front of a scientific audience. Current presentation techniques will be learned as well as the capability to critically and constructively discuss work of other researchers*	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Agricultural Entomology Seminar (Seminar) *Inhalte*: Im Rahmen dieser Veranstaltung werden die Forschungsziele, Methoden und Ergebnisse aus aktuellen Projekten in der Agrarentomologie von Studierenden vorgestellt. Die Ergebnisse werden diskutiert und Anregungen und Ausblicke für weiterführende Arbeiten gegeben. *Current projects as well as important literature in the field of agricultural entomology will be presented by the students. The research will be critically discussed.*	2 SWS
Prüfung: Präsentation, Referat oder Korreferat (ca. 20 Minuten) **Prüfungsvorleistungen:** Teilnahme an 12 Seminaren **Prüfungsanforderungen:** Sehr gute Kenntnisse des eigenen Forschungsgebietes und der entsprechenden Präsentationsanforderungen. PC-Präsentation eigener Ergebnisse in englischer Sprache, Teilnahme und Diskussion. *Assessment requirements are a very good knowledge of the relevant research field, a seminar presentation in English and active participation in the discussion.*	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Michael Georg Rostás
Angebotshäufigkeit: jedes Semester	**Dauer:** 2 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

30	

Georg-August-Universität Göttingen **Modul M.Cp.0012: Weed Biology and Weed Management** *English title: Weed biology and weed management*	6 C 4 SWS
Lernziele/Kompetenzen: Kenntnisse der wichtigsten Unkräuter mit ihren Lebensformen, Strategien und Schadwirkungen. Verständnis der Dynamik von Unkrautpopulationen und den Populationsparametern. Kenntnisse von Möglichkeiten und Grenzen der Unkrautbekämpfungsmethoden. Ableiten von Entscheidungskriterien beim Unkrautmanagement. Fähigkeit zur eigenständigen theoretischen Bearbeitung eines herbologischen Problems. Verständnis für internationale Aspekte von Unkrautpopulationen und Unkrautmanagement	**Arbeitsaufwand:** Präsenzzeit: 30 Stunden Selbststudium: 150 Stunden
Lehrveranstaltung: Weed Biology and Weed Management (Vorlesung, Exkursion, Seminar) *Inhalte*: Das Modul beschäftigt sich mit der Biologie von Unkräutern und den Verfahren des Managements von Unkrautpopulationen. Es werden die wichtigsten botanischen und populationsbiologischen Grundlagen der Herbologie vorgestellt. Wichtige Unkräuter Europas und der Welt mit ihren Schadwirkungen werden behandelt. Als Managementverfahren werden direkte chemische, physikalische und vorbeugende ackerbauliche Bekämpfungsmethoden vorgestellt. Aktuelle, durch Unkräuter hervorgerufene ackerbauliche Probleme werden besprochen. Rechtliche und internationale Aspekte des Unkrauts werden behandelt. Im Rahmen des Seminars werden von den Studierenden aktuelle Forschungsergebnisse vorgestellt und im Kontext mit dem Vorlesungsstoff diskutiert.	4 SWS
Prüfung: **Prüfungsanforderungen:** Grundlegende Kenntnisse der Unkrautbiologie und Populationsmerkmalen; Kenntnisse der Wirkungsweise der wichtigsten Bekämpfungsverfahren mit Fallbeispielen; Kenntnisse über weltweit bedeutende Unkräuter und deren Management. Fähigkeit Unkrautpopulationen aktueller Ackerbausysteme einzuordnen und Bekämpfungsstrategien zu entwickeln	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Jean Wagner
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Module M.Cp.0014: Plant Nutrition and Plant Health**	3 C 2 WLH
Learning outcome, core skills: Knowledge of and ability to present the presented topics in their context: development of nutritional and processing quality in different crop plants; quality requirements and ways of realization by crop production methods.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Plant Nutrition and Plant Health (Lecture, Seminar) *Contents*: Nutrient uptake and transport in the plant; function of different nutrients in the plant especially with respect to plant health (susceptibility, tolerance, resistance); mechanisms to increase the efficiency of nutrient availability, uptake and use; characteristics of plant health, effect of nutrient imbalances on plant metabolism and development of plant harvest products, the nutrient concentrations and processing quality.	2 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Understanding the relationship between plant nutrition and plant health and its significance in the value-added food chain.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Klaus Dittert
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.Cp.0015: Molecular Weed Science**	6 C 4 WLH

Learning outcome, core skills: Understanding the basic principles of the interactions between herbicides and the target plant and herbicide selectivity. Resistance mechanisms in weeds and mechanisms of tolerance in cultivated plants are understood, can be distinguished and practical consequences be drawn. Students have a fundamental understanding of the development and distribution of herbicide resistance in weeds.	**Workload:** Attendance time: 60 h Self-study time: 120 h

Course: Molecular Weed Science (Lecture, Practical course) *Contents*: **Lecture**: In the lecture the application of molecular methods in weed science and weed magement is presented, focusing on the naturally occurring herbicide resistance in weeds. The genetic basis will be taught with regard to transgenic and non transgenic herbicide tolerance in cultivated plants. The possibilities of the use of molecular techniques for the detection of herbicide resistance in weeds will be discussed. New findings by the so called –omics (genomics, proteomics and metabolomics) on the interaction of weeds with their environment are of impotance in thedevlopment of new herbicides and will be discussed as well as alternative transgenic approaches in weed management. **Practical:** Practical laboratory sessions are held in addition to the lectures. In the practical actual resistance problems in weeds are presented. Resistance detection methods will be presented and carried out on the protein level (target assay) and on the genetic level (SNP-analysis') and the possible use for a sustainable herbicide weed management will be discussed.	4 WLH
Examination: Written examination (90 minutes) **Examination prerequisites:** Participitation in the lectures and lab practica.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Jean Wagner
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Cp.0016: Practical statistics and experimental design in agriculture**	6 C 4 WLH
Learning outcome, core skills: The aim of the course is to familiarize students with the basic concepts of statistics and their application in agricultural science. The second goal is to learn the use of software packages like SAS.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Practical Statistics and Experimental Design in Agriculture (Lecture, Exercise) *Contents*: In the beginning of the course, students are introduced to the basic concepts of statistics like frequency distributions, the normal distribution and hypothesis testing. They are also introduced to software packages like SAS, that are used for the practical exercises. Regression and correlation analysis are then introduced. Different experimental designs like randomized block, latin square, and split plot are described and analyzed by one-way analysis of variance or as factorial experiments. Generalized Linear Models will be used and multivariate data will by analyzed by cluster and principal component methods. A large amount of examples and exercises constitute an important aspect of the course, enabling the students to understand and assimilate the theoretical content. Practical analyses of example data sets also provide the students with the required experience and skills for future statistical tasks in the context of Mastertheses.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Knowledge of the basic concepts of statistics and their application in agricultural science and in the use of software packages like SAS.	6 C

Admission requirements: none	**Recommended previous knowledge:** Mathematics, statistics
Language: English	**Person responsible for module:** Dr. Christian Kluth
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Additional notes and regulations:
This module and M.Agr.0036 "Methodisches Arbeiten: Versuchsplanung und -auswertung" are mutually exclusive.

Georg-August-Universität Göttingen **Modul M.Cp.0017: Scientific Presenting, Writing and Publishing in Crop Protection** *English title: Scientific presenting, writing and publishing in crop protection*	3 C 2 SWS

Lernziele/Kompetenzen: Strukturieren und Schreiben von wissenschaftlichen Texten in englischer Sprache, Gestaltung von Graphiken und Tabellen, Literaturrecherche, Zitieren, Erstellen von Präsentationen in Form von Postern und Vorträgen, Review von Manuskripten anderer Autoren. Die Studierenden lernen weiterhin den Ablauf des Publikationsprozesses vom Schreiben und Einreichen des Manuskriptes bis zum Review-Verfahren kennen.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Scientific Presenting, Writing and Publishing in Crop Protection (Vorlesung, Seminar) *Inhalte*: Das Erkennen der Struktur und Gedankenführung in Publikationen wird anhand der Beispiele vermittelt und danach selbständig erarbeitet. Kriterien für Qualität und Qualitätsmängel werden angewendet.	2 SWS
Prüfung: Hausarbeit (max. 10 Seiten) **Prüfungsvorleistungen:** Teilnahme an 12 Seminaren **Prüfungsanforderungen:** Vermittlung der Methoden zur Beschaffung und Verwendung der Inhalte aus wissenschaftlichen Texten zu einem Thema.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Andreas von Tiedemann
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 2
Maximale Studierendenzahl: 20	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.Cp.0018: Journal Club on New Topics in Crop Protection
English title: Journal club on new topics in crop protection</td><td>3 C
2 SWS</td></tr>
</table>

<table>
<tr><td>Lernziele/Kompetenzen:
Die Studierenden erwerben Kompetenzen in der Erschließung und Diskussion eines wissenschaftlichen Themas aus dem Bereich der Literatur zum Pflanzenschutz sowie der mündlichen und schriftlichen Wiedergabe des Stoffes.</td><td>Arbeitsaufwand:
Präsenzzeit:
28 Stunden
Selbststudium:
62 Stunden</td></tr>
</table>

<table>
<tr><td>Lehrveranstaltung: Journal Club on New Topics in Crop Protection (Vorlesung, Seminar)
Inhalte:
Vermittlung der Methoden zur Beschaffung und Verwendung der Inhalte aus wissenschaftlichen Texten zu einem Thema.</td><td>2 SWS</td></tr>
<tr><td>Prüfung: Präsentation, Referat oder Korreferat (ca. 20 Minuten) mit schriftlicher Ausarbeitung (max. 10 Seiten)
Prüfungsvorleistungen:
Teilnahme an 12 Seminaren
Prüfungsanforderungen:
Erarbeitung eines literaturbasierten Seminarvortrags mit Diskussion und Kurzfassung</td><td>3 C</td></tr>
</table>

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Andreas von Tiedemann
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 2
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen Module M.Cp.0019: Basic Laboratory Techniques	3 C 2 WLH
Learning outcome, core skills: Sicheres und verantwortungsbewusstes Verhalten im Laboralltag (Chemie, Mikrobiologie) als Voraussetzung für eine experimentelle Masterarbeit in der Phytopathologie. Logisches Planen, Vorbereiten und Auswerten von Versuchen, systematisches und logisches Erklären von Methoden und Gerätebedienung.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Basic Laboratory Techniques (Exercise) *Contents*: Das Praktikum vermittelt die theoretischen Grundlagen des Arbeitens in einem chemisch-mikrobiologischen Labor und die Bedienung wichtiger Geräte an Hand von Versuchen: Laborsicherheit, Umgang mit Chemikalien, Fachrechnen, (Konzentrationen in Medien und Puffern), grundlegende mikrobiologische Methoden (Medienherstellung, Sterilisationsverfahren, steriles Arbeiten, Lichtmikroskopie, Keimzahlbestimmung), pH-Wert, pH-Meter, Puffer, Photometrie, Zentrifugation, Versuchsvorbereitung und Protokollführung, Übung von Anleitungssituationen.	2 WLH
Examination: Written examination (45 minutes) **Examination prerequisites:** Akzeptiertes Protokoll **Examination requirements:** Grundlagenkenntnisse in der Berechnung von Konzentrationen, Sterilisationstechniken, der Bedeutung und Zusammensetzung von Puffern, über das Prinzip der Photometrie und Zentrifugation, von Lebend- und Gesamtzellzahlbestimung.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Anke Sirrenberg
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Cp.0020: Ecotoxicological Risk Assessment for Plant Protection Products**	3 C 2 WLH
Learning outcome, core skills: To gain a basic knowledge of ecotoxicology and understanding its principles and associated testing and ecological risk assessment methods, specifically for application to plant protection products.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Ecotoxicological Risk Assessment for Plant Protection Products (Lecture, Exercise) *Contents*: In this module, students will be lectured on the basics of risk assessment for plant protection products. The most important aspects and definitions in the field of exposure, selection of representative test species, (statistical) data evaluation and risk assessment will be discussed. The for registration purposes considered organism groups, i.e. birds, mammals, aquatic organisms (incl. fish, invertebrates, primary producers), honeybees, soil organisms (incl. earthworms), non-target arthropods and non-target plants, and the corresponding data requirements will be reviewed. Specific aspects of exposure and assessment of each of these organism groups will be discussed. Furthermore, the importance of ecotoxicology in the registration process of a plant protection product will be discussed. The theoretical basis will be handled in the lectures and subsequently some aspects will then be applied in the practical part. This includes: - Methods in ecotoxicology (e.g. standardisation and quality of testing) - Exposure pathways, bioavailability - Selection of test species and testing methods - Risk assessment and risk management In the practical part, students will learn to design, conduct and evaluate acute toxicity tests with plant protection products in the laboratory. It is planned to use test species from the group of arthropods, mainly insect larvae (depending on animal availability). The aim of the tests is to obtain a dose-response relationship and (mathematically) derive EC50 or LC50 values and also, if the data permit, to (statistically) derive NOEC and LOEC values. Finally, a choice of publically available European registration dossiers will be reviewed and critically discussed.	2 WLH
Examination: Written examination (60 minutes) **Examination requirements:**	3 C

Knowledge of ecotoxicological testing methods and their evaluation for the risk assessment of plant protection products.	

Admission requirements: Plant Health/Crop Protection	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Lennart Weltje
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 15	

Georg-August-Universität Göttingen **Module M.Cp.0022: Internship PlantHealth**	6 C 6 WLH

Learning outcome, core skills: Fachbezogene Kenntnisse des jeweiligen Arbeitgebietes, soziale Kompetenzen (Arbeitsorganisation, Teamarbeit, Interdisziplinäres Arbeiten, Flexibilität), praktisch methodische Kompetenzen.	**Workload:** Attendance time: 160 h Self-study time: 20 h

Course: Internship PlantHealth (Internship) *Contents*: Praktische Mitarbeit in unterschiedlichen Bereichen des Pflanzenschutzes, Industrie, Ressortforschung, Beratung. Einblick in Arbeitsmethoden, Aufgaben, Berufsalltag im Pflanzenschutz. Erwerb praktisch-anwendungsbezogener Kenntnisse. Praktikumsdauer: 6 Wochen	6 WLH
Examination: Seminararbeit (max. 20 Seiten) **Examination requirements:** Praktische Mitarbeit in unterschiedlichen Bereichen des Pflanzenschutzes, Praktikumsbericht.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Andreas von Tiedemann
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Cp.0023: Plant Pathogenic Bacteria**	3 C 2 WLH
Learning outcome, core skills: Students gain knowledge on the most important plant pathogenic bacteria, their biology, dissemination, life cycle, diagnosis and control, as well as on their molecular and taxonomic features. They are able to understand the theoretical background and to apply in practice gained knowledge. In particular, students are able to recognize plant bacterial diseases presented during this course and to make a preliminary diagnosis. They critically evaluate scientific and non-scientific publications on plant pathogenic bacteria, and know where to find relevant and reliable information. Students are able to prepare a scientific presentation according to the standards of international conferences and use interactive teaching material.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Plant Pathogenic Bacteria (Lecture, Seminar) *Contents*: Blended learning module; this module comprises general and specific part. The general part addresses the following topics: history of phytobacteriology; origin and evolution of phytopathogenic bacteria; diversity and taxonomy of phytopathogenic bacteria; general features of phytopathogenic bacteria, their cultivation and preservation; epidemiology and ecology of plant bacterial diseases, and economical significance; pathogenesis, host-pathogen interactions and symptomatology; diagnosis and management of plant bacterial diseases, including use of bacteriophages. The specific part is organized in separate lessons, according to the main bacterial taxa causing diseases on plants. In particular, it covers the most important phytopathogenic bacteria and diseases they cause, and includes sections on their distribution, economical significance, symptomatology, epidemiology, pathogen characteristics and disease management.	2 WLH
Examination: Written exam, 45 min 50% ; Student presentation with discussion, 50%	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Andreas von Tiedemann Dr. Kuzmanovic; Dr. Susanne Weigand
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: three times	**Recommended semester:** 1 - 3
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Cp.0024: Digital Techniques for Crop Monitoring**	6 C
Learning outcome, core skills: Learning outcome, core skills: The module teaches basic principles for the use of digital tools in greenhouse and field experiments. It covers camera-based methods for single plant and plot scale (RGB, spectral, 3D) as well as the use of GPS for georeferenced measurements. Furthermore, the analysis of data, for single recordings and time series, is taught. Upon completion of the module, the students are able to independently carry out measurements with selected technologies of crop plants according to a measurement protocol, combine reference measurements, carry out analyses and compile results. Furthermore, they can plan complex measurement procedures for their own experimental projects and assess the effort involved. Finally they obtain skills to interpret sensor data with an agricultural meaning.	**Workload:** Attendance time: 40 h Self-study time: 140 h
Course: Digital Techniques for Crop Monitoring (Block course, Internship) *Contents*: In the course, selected topics on the use of digital technologies in field experiments for crop science are focused. The students are enabled to actively use optical sensors. In addition to data acquisition, the main content focuses on the processing of raw data, evaluation, and combination with reference data. Reference data is extracted with established tools from the plant sciences and geo-referenced in the field using GPS, in a way that an allocation to the optical measurement methods is possible. Data acquisition is carried out using digital carrier platforms (robot, drone, etc.). Another essential content is the summary of metadata of field trials in order to store trial data in such a way that they can be reused and used by third parties. The module is divided into two sub-aspects: (i) Theoretical basics as a lecture and (ii) hands-on exercises with digital technologies. While the practical handling is taught in the exercises, the theoretical lecture teaches the overall context, the differences between the sensors, as well as the analysis using sample data sets, and the application of complex evaluation algorithms. *Literature: latest publication from the providing institute* *Course frequency:* each winter semester	
Examination: Providing a technical video (5 Minutes). This professional video includes a structured introduction into the topic (sensors and measuring) Idea description and screenplay must be provided. **Examination prerequisites:** Regular participation in the block course **Examination requirements:** Understanding of digital methods and sensor technologies and their application at different scales. Deep understanding of the planning of a digital survey in field testing. Knowledge of methods of evaluation, referencing and interpretation of optical sensor data.	6 C

Admission requirements:	Recommended previous knowledge:
none	none
Language: English	**Person responsible for module:** Prof. Anne-Katrin Mahlein, Dr. Stefan Paulus
Course frequency: 1	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 1
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Cp.0025: Analytical Techniques for Foods and Agricultural Research**	6 C 4 WLH

Learning outcome, core skills: This module aims to provide students with a comprehensive understanding of chemical analysis techniques employed in agricultural research through a combination of practical experiments and lectures, which will cover the analysis of major chemical groups in plants, fungi, and pesticide residues.	**Workload:** Attendance time: 70 h Self-study time: 110 h

Course: Analytical Techniques for Foods and Agricultural Research (Lecture, Practical course) *Contents*: The module will include various topics related to chemical analysis methods in agricultural sciences. The analysis of plant primary and secondary metabolites (such as carbohydrates, amino acids, organic acids, phytohormones, phytoalexins, glucosinolates, and volatiles) will be discussed. Moreover, the analysis of mycotoxins, fungal secondary metabolites, and pesticide residues will be covered. The module will introduce the fundamental analytical chemistry methods, including sample preparation, separation techniques, detection methods, characterization, and quantification of metabolites using state-of-the-art chromatographic and mass spectrometric methods.	4 WLH
Examination: oral exam (30 min, 70%), Student presentation with discussion (ca. 20 min presentation + ca. 10 min discussion, 30%)	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Mohammad Alhussein
Course frequency: not specified	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 16	

Georg-August-Universität Göttingen Universität Kassel/Witzenhausen Module M.SIA.E13M: Microeconomic theory and quantitative methods of agricultural production	6 C 4 WLH
Learning outcome, core skills: Microeconomic Theory of Agricultural Production Students are familiar with microeconomic approaches and can apply them to analyze issues related to agriculture and rural development. Quantitative Methods in Agricultural Business Economics Students are familiar with quantitative methods used for the analysis and planning of farms and enterprises in the agricultural sector.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Microeconomic theory of agricultural production (Lecture) *Contents*: Consumer theory, producer theory, markets, monopoly situations, risk and uncertainty, economics of technical change, farm household models, sharecropping contracts.	2 WLH
Course: Quantitative methods in agricultural business economics (Lecture) *Contents*: Budgeting, accounting, annual balance sheets, linear programming, finance, investment analysis.	2 WLH
Examination: Written examination (120 minutes) **Examination requirements:** Consumer theory; producer theory; risk; technological progress; farm household models; budgeting and accounting; linear programming; finance; investment analysis.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Oliver Mußhoff Vanessa Bonke
Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 40	

Additional notes and regulations:
Literature:
Text books, research articles and lecture notes.

After successful conclusion of M.Agr.0060 students can not complete M.SIA.E13M

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Modul M.SIA.P07: Soil and plant science** *English title: Soil and plant science*	6 C 4 SWS
Lernziele/Kompetenzen: Brückenmodul um die neuesten Kenntnisse in den pflanzenbaulichen Grundlagenfächern insbesondere im Hinblick auf Fragen der ökologischen Landwirtschaft, die üblicherweise so nicht gelehrt werden, zu vermitteln. Studierende, die diesen Kurs besucht haben können den weiterführenden pflanzenbaulichen Modulen folgen.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
Lehrveranstaltung: Soil and plant science (Vorlesung, Seminar) *Inhalte*: Einfluss von Bodenbildungsprozessen auf physikalische Eigenschaften (Bodenart, Bodenwasser, Porenraum), chem. Eigenschaften (Puffervermögen, Austauschkapazität, Nährstoffe) und biol. Eigenschaften (organische Substanz, Edaphon). Nährstoffverfügbarkeit und Nährstoffmobilisierung unter konventionellen und ökologischen Anbaubedingungen, Haupt- und Spurennährstoffe und Nahrungsqualität. Züchtungsziele für unterschiedliche landwirtschaftliche Systeme: Pflanzenmorphologie, -genetik und –züchtung, Pflanzendomestikation und Nutzung, Charakterisierung und Beurteilung, Nutzung genetischer Ressourcen in der Pflanzenzüchtung. Genetik von Wirts-Parasit Interaktionen, Epidemiologie der Pflanzenkrankheiten, Pflanzenabwehrmechanismen, Insektenphysiologie und –ökologie. Spezifische allgemeine und wissenschaftliche Artikel, die sich mit dem Zielland der Exkursion befassen werden über eine E-Learning Plattform zur Verfügung gestellt	4 SWS
Prüfung: Klausur (120 Minuten) oder Fachgespräch (ca. 20 Minuten) **Prüfungsanforderungen:** Physikalische Eigenschaften (Bodenart, Bodenwasser, Porenraum); chem. Eigenschaften (Puffervermögen, Austauschkapazität, Nährstoffe); biol. Eigenschaften (organische Substanz, Edaphon); Bodenbildung und –klassifikation. Rolle der Haupt- und Spurennährstoffe in Pflanzen, Nährstoffverfügbarkeit und Nährstoffmobilisierung, Pflanzennährstoffe und Nahrungsqualität. Pflanzenmorphologie, -genetik und –züchtung, Prinzipien der Pflanzendomestikation und Nutzung, Charakterisierung und Beurteilung, Nutzung genetischer Ressourcen in der Pflanzenzüchtung, genetische Grundlagen für die Züchtung. Prinzipien der Pflanzenkrankheiten und Entomologie, Entstehung von Pflanzenkrankheiten, Epidemiologie, Pflanzenabwehrmechanismen, Insektenphysiologie und –ökologie.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine

Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Helmut Saucke
Angebotshäufigkeit: jedes Wintersemester; Witzenhausen	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Modul M.SIA.P15M: Methods and advances in plant protection** *English title: Methods and advances in plant protection*	6 C 4 SWS

Lernziele/Kompetenzen: Studierende sind imstande, veröffentlichte Ergebnisse kritisch zu evaluieren und dieses Wissen auf aktuelle Probleme im Feld anzuwenden. Ebenso sind sie imstande, Probleme zu identifizieren und experimentelle und analytische Lösungsansätze zu formulieren.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden

Lehrveranstaltung: Methods and advances in plant protection (Vorlesung, Exkursion, Übung) *Inhalte*: • Fortgeschrittener Kurs in Pflanzenschutz (Entomologie und Pathologie) • Methodologie und Auswertungsmethoden im Pflanzenschutz • Fallstudien spezieller Pflanzenschutzthemen im ökologischen Anbau in Form von Vorlesungen, Seminar und praktischen Übungen	4 SWS
Prüfung: Klausur (120 Minuten) oder Fachgespräch (ca. 20 Minuten) (Gewichtung: 70%) und Protokoll (max. 3 Seiten) oder Referat (ca. 10 Minuten) (Gewichtung: 30%) **Prüfungsanforderungen:** Fortgeschrittenes Wissen im Pflanzenschutz (Entomologie und Pathologie), Methodologie und Auswertungsmethoden im Pflanzenschutz anhand von Fallstudien spezieller Pflanzenschutzthemen.	6 C

Zugangsvoraussetzungen: Pflanzenschutz (mindestens 6 ECTS) oder Brückenmodul M.SIA.P07 Soil and Plant Science	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Maria Renate Finckh
Angebotshäufigkeit: jedes Wintersemester; Witzenhausen	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen Universität Kassel/Witzenhausen **Modul M.SIA.P22: Management of tropical plant production systems** *English title: Management of tropical plant production systems*	6 C 4 SWS
Lernziele/Kompetenzen: Kenntnisse der botanischen, ökologischen und agronomischen Fakten der vorgestellten Nutzpflanzen und Anbausysteme, Zuordnung von Nutzpflanzen und Anbausystemen zu verschiedenen Standortbedingungen und systemorientierte Beurteilung einer nachhaltigen Produktion an ausgewählten Standorten.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden
Lehrveranstaltung: Management of tropical plant production systems (Vorlesung) *Inhalte*: Vorstellung der wichtigsten Nutzpflanzen der Tropen und Subtropen bezüglich Botanik, Morphologie, Herkunft, klimatischer und ökologischer Ansprüche, Anbausystem, Ernteverfahren, Bedeutung in Landnutzungssystemen, Nutzung als Nahrungsmittel, Futter, Rohstoff und zur Energiegewinnung aus Biomasse. Diskussion der verschiedenen Anbausysteme in den Tropen und Subtropen und des spezifischen Managements für eine nachhaltige Steigerung der Produktivität **Literatur** Rehm, S., Espig, G. 1991: The Cultivated Plants of the Tropics and Subtropics. Verlag Josef Margraf. Weikersheim, Germany; lecture notes	4 SWS
Prüfung: Written exam (90 minutes) or oral exam (ca. 30 minutes) **Prüfungsanforderungen:** Wissen der botanischen, ökologischen und agronomischen Fakten der vorgestellten Nutzpflanzen und Anbausysteme. Kenntnisse der Zuordnung von Nutzpflanzen und Anbausystemen an verschiedene Standortbedingungen, sowie systemorientierte Beurteilung einer nachhaltigen Produktion an ausgewählten Standorten.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Reimund Paul Rötter
Angebotshäufigkeit: jedes Wintersemester; Göttingen	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 35	

Bemerkungen:
Die schriftliche Prüfung erfolgt am ersten, die mündliche Prüfung am zweiten Termin.

Georg-August-Universität Göttingen Module M.WIWI-QMW.0004: Econometrics I	6 C 6 WLH
Learning outcome, core skills: This course enables students to approach empirical research problems within the framework of the linear regression model, including model specification and selection, estimation, inference and detection of heteroscedasticity and autocorrelation. Moreover, the students can apply the methods discussed to real economic data and problems using the statistical software package R and they are able to assess estimator properties (finite sample and asymptotic). This course enables students to access more advanced topics in econometrics.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Econometrics I (Lecture) *Contents*: The lecture covers the following topics: 1. Introduction to the basic multiple regression model, model specification, OLS estimation, prediction and model selection, Multicollinearity and partial regression. 2. The normal linear model, including maximum likelihood and interval estimation, hypothesis testing. 3. Asymptotic properties of the OLS and (E)GLS estimators. 4. Generalized linear model: GLS and EGLS estimators, properties of these, heteroskedastic and autocorrelated models, testing for heteroscedasticity and autocorrelation.	2 WLH
Course: Econometrics I (Exercise) *Contents*: The practical deepens the understanding of the lecture topics by applying the methods from the lecture to economic problems and data, and reviewing and intensify theoretical concepts.	2 WLH
Course: Econometrics I (Tutorial) *Contents*: The tutorials are small classes with max. 20 students, which give room for applying the concepts to specific problem sets and discussing questions, that students might encounter regarding the concepts addressed in the lecture and practical. A part of the tutorial are hands-on computer exercises using the software R. This enables students to conduct regression analysis in practice and prepares them for others (applied) courses.	2 WLH
Examination: Written examination (90 minutes)	6 C
Examination requirements: The students demonstrate their understanding of basic econometric concepts. They show that they can apply these concepts to real economic problems.	

Admission requirements: none	**Recommended previous knowledge:** Basic knowlegde in statistics and mathematics
Language: English	**Person responsible for module:** Prof. Dr. Helmut Herwartz

Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 2
Maximum number of students: not limited	

Fakultät für Agrarwissenschaften:

Nach dem Beschluss des Fakultätsrats der Fakultät für Agrarwissenschaften vom 21.12.2023 hat das Präsidium der Georg-August-Universität Göttingen am 31.01.2024 die Neufassung des Modulverzeichnisses zur Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang „Integrated Plant and Animal Breeding“ genehmigt (§ 44 Abs. 1 Satz 2 NHG, §§ 37 Abs. 1 Satz 3 Nr. 5 b), 44 Abs. 1 Satz 3 NHG).

Georg-August-Universität
Göttingen

Modulverzeichnis

für den konsekutiven Master-Studiengang "Integrated Plant and Animal Breeding" - zu Anlage 3 der Prüfungs- und Studienordnung für Master-Studiengänge der Fakultät für Agrarwissenschaften (Amtliche Mitteilungen I Nr. 26/2023 S. 863)

Module

Übersicht nach Modulgruppen

I. Master-Studiengang "Integrated Plant and Animal Breeding"

1. Block A - Compulsory Modules

Es müssen die vier folgenden Pflichtmodule im Umfang von insgesamt 27 C erfolgreich absolviert werden:

The following four compulsory modules worth overall 27 C must be successfully completed:

2. Block B - Elective compulsory modules

Es müssen wenigstens vier der folgenden Wahlpflichtmodule im Umfang von insgesamt wenigstens 21 C erfolgreich absolviert werden:

Out of the following elective compulsory modules at least four modules worth overall at least 21 C must be successfully completed:

3. Block C - Key competencies

Es müssen die folgenden Module im Umfang von insgesamt 12 C erfolgreich absolviert werden:

The following two compulsory modules worth overall 12 C must be successfully completed:

4. Block D - Elective modules

Es müssen weitere 5 Module im Umfang von insgesamt wenigstens 30 C aus dem Lehrangebot eines Master-Studienganges der Fakultät für Agrarwissenschaften in Göttingen oder frei wählbare Module aus den am diesem Studiengang beteiligten Einrichtungen, einer entsprechenden anderen agrarwissenschaftlichen Fakultät oder aus verwandten Studiengängen erfolgreich abgeschlossen werden.

Five additional modules worth overall at least 30 C must be successfully completed. Students can earn the credits through elective modules from any master study programme at the faculty of agriculture, University of Goettingen, from other institutions participating in the programme, or from other agricultural faculties or similar study programmes at other universities.

5. Master's thesis

Durch die erfolgreiche Anfertigung der Masterarbeit werden 24 C erworben.

Completion of the Master's thesis is worth 24 Credits.

6. Colloquium for the Master's thesis

Durch das erfolgreiche Absolvieren des Kolloquiums zur Masterarbeit werden 6 C erworben.

Successful completion of the colloquium for the Master's thesis is worth 6 Credits.

II. Double-Degree Programme "European Master of Animal Breeding and Genetics" (EMABG)

Es sind Leistungen im Umfang von insgesamt 120 C erfolgreich zu absolvieren. Leistungen im Umfang von 60 C müssen nach Maßgabe der folgenden Bestimmungen an der Universität Göttingen erfolgreich absolviert werden, weitere 60 C, darunter die Masterarbeit, müssen an einer der Partneruniversitäten erfolgreich absolviert werden.

Modules worth overall 120 C must be successfully completed. Modules worth 60 C must be completed following the regulations of the University of Goettingen. Another 60 C, including the Master’s thesis, must be earned and completed at one of the partner universities.

1. Block A - Compulsory modules

Die folgenden fünf Pflichtmodule im Umfang von insgesamt 33 C müssen erfolgreich absolviert werden:

The following five compulsory modules worth overall 33 C must be successfully completed:

2. Block B - Elective compulsory modules

Mindestens vier Module im Umfang von insgesamt wenigstens 27 C müssen erfolgreich absolviert werden. Davon müssen mindestens zwei Module im Umfang von insgesamt mindestens 9 C aus einer Studienrichtung (Buchstaben a.-c.) absolviert werden.

At least four modules worth overall at least 27 C must be successfully completed. From these at least two modules worth overall at least 9 C must be completed from a particular study track (letters a-c).

a. Study Track "Integrative Biology"

b. Study Track "Genomic selection"

c. Study Track "Biological and societal context of breeding"

Only one of the moduls M.SIA.E11 and E13M can be chosen.

d. Other modules

e. Alternative modules

Es können anstelle der genannten Module andere Module (Alternativmodule) nach Maßgabe der nachfolgenden Bestimmungen belegt werden. Voraussetzungen für die Berücksichtigung eines Alternativmoduls ist ein schriftlicher Antrag der oder des Studierenden, der vor der Belegung des Alternativmoduls an die Studiendekanin oder den Studiendekan der Fakultät für Agrarwissenschaften zu richten ist. Die Entscheidung über die Genehmigung des Antrags trifft die Studiendekanin oder der Studiendekan der Fakultät für Agrarwissenschaften. Diese oder dieser wird vor der Entscheidung eine Stellungnahme über die Zweckmäßigkeit des Modulersatzes von Lehrenden des Studiengangs einholen, für den die oder der Studierende eingeschrieben ist. Der Antrag kann ohne Angabe von Gründen abgelehnt werden; ein Rechtsanspruch der oder des antragstellenden Studierenden besteht nicht.

In place of the modules listed above, it is also possible to complete other modules (alternative modules) in compliance with the following regulations. As a prerequisite for the consideration of an alternative module, the student must submit a written application addressed to the Studiendekan or Studiendekanin (dean of studies) at the faculty of agriculture. The student must submit the application before attending the respective module. The decision over the notification of acceptance or rejection will be made by the Dean of Study from the faculty of agriculture. Before reaching a decision, he or she will request a written statement from the teaching staff of the respective study programme, on the basis of which to judge the adequacy of requested replacement of modules. The student's application can be rejected without any explicit declaration of reasons; the student possesses no legal claim with respect to the permission of alternative modules.

Georg-August-Universität Göttingen **Modul M.Agr.0020: Genome analysis and application of markers in plantbreeding** *English title: Genome Analysis and Application of Markers in Plantbreeding*	6 C 4 SWS
Lernziele/Kompetenzen: Studierende erlernen ihre Kenntnisse in klassischer Genetik auf Problemlösungen in züchterischen Situationen anzuwenden. Studierende erlernen selbständig sich Kenntnisse im Umgang mit großen Datensätzen anzueignen und sich in entsprechende Software einzuarbeiten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Genome analysis and application of markers in plantbreeding (Vorlesung, Übung) *Inhalte*: Überblick über verschiedene Typen von molekularen Markern. Schätzung von genetischen Distanzen. Grundlagen der klassischen Genetik zur Kopplungsanalyse. Konstruktion von Kopplungskarten. Markergestützte Rückkreuzung. Kartierung von QTL: Theorie und praktische Übungen mit großen Datensätzen aus früheren Experimenten. Grundlagen der Bioinformatik: Vergleich von DNA Sequenzen.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Abgabe der Lösung von Übungsaufgaben **Prüfungsanforderungen:** Grundlagenkenntnisse in klassischen und molekularen Methoden der Kartierung von Genen. Basiskenntnisse im Einsatz molekularer Marker in der Pflanzenzüchtung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** apl. Prof. Dr. Wolfgang Link PD Dr. Wolfgang Ecke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Agr.0056: Plant breeding methodology and genetic resources** *English title: Plant Breeding Methodology and Genetic Resources*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden lernen, klassische und molekulare Methoden und Techniken bei der Lösung pflanzenzüchterischer Problemen zu integrieren. Sie lernen, eigene Schlussfolgerungen aus klassischen und neuesten Veröffentlichungen zu ziehen und diese Wissenschaftlern und Studierenden verständlich, knapp und klar zu vermitteln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Plant breeding methodology and genetic resources (Vorlesung) *Inhalte*: Grundlagen der Zuchtmethodik: Populationsgenetik, Zuchtmethoden in der Klon-, Linien-, Hybrid- und Populationszüchtung, Marker-gestützte Selektion für monogene und polygene Merkmale. Nutzung pflanzengenetischer Ressourcen: Wildarten, ex-situ und in-situ-Erhaltung, on-farm-Management. Züchtung für marginale Standorte mit Beispielen aus gemäßigten und tropischen Breiten. Dieses Modul und das Modul "Genetic Principles of Plant Breeding" ergänzen sich wechselseitig.	4 SWS
Prüfung: Klausur (Gewicht: 80%, Dauer: 90 Minuten) und Präsentation, Referat oder Korreferat (Gewicht: 20%, Dauer: ca. 20 Minuten) **Prüfungsanforderungen:** Grundlagen zu: Populationsgenetik, Einsatz von Markern in der Pflanzenzüchtung, Konzepte zur Nutzung Pflanzengenetischen Ressourcen. Gute Kenntnisse: 'Pre-Breeding', Kategorien und Methoden der Pflanzenzüchtung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** apl. Prof. Dr. Wolfgang Link
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Module M.Agr.0186: Multivariate Statistics with Applications in Agricultural Sciences**	6 C 4 WLH
Learning outcome, core skills: The students will get a comprehensive overview of multivariate statistics from both a theoretical and applied perspective. This module aims to teach fundamental skill on how to approach analysis of univariate and multivariate datasets and how to interpret results. Practical applications will partially be performed in the software R.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Multivariate statistics with applications in agricultural sciences (Lecture) *Contents*: • Multivariate regression • Multivariate random variables • Multivariate testing • Principal components analysis • Factor analysis • Cluster analysis • Multidimensional scaling • MANOVA • Neural Networks	4 WLH
Examination: Written examination (90 minutes) **Examination prerequisites:** Working on 50% of the exercises and presentation of the solution of at least one exercise, as well as active participation in the exercises.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic courses in math or statistics. Examples for this could be M.Agr.0036 (Methodisches Arbeiten: Versuchsplanung und –auswertung), M.Agr.0076 (Statistische Nutztiergenetik), M.iPAB.0015 (Applied Machine Learning in Agriculture in R).
Language: English	**Person responsible for module:** N. N.
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Georg-August-Universität Göttingen **Modul M.Cp.0004: Plant Diseases and Pests in Temperate Climate Zones** *English title: Plant diseases and pests in temperate climate zones*	6 C 4 SWS

Lernziele/Kompetenzen: Kenntnis and Diagnose von Krankheiten und tierischen Schädlingen an Kulturpflanzen. Verständnis der Entstehung, Verbreitung und Dynamik von Schaderregern im Feld als Grundlage für die Entwicklung von Bekämpfungsmaßnahmen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Plant Diseases and Pests in Temperate Climate Zones (Vorlesung, Exkursion, Übung) *Inhalte*: Es werden die in gemäßigten Zonen an Kulturpflanzen auftretenden, wichtigsten Schadorganismen (Viren, Bakterien, Pilze, Nematoden, Milben, Insekten, u.a.) eingehend behandelt. Neben der Erkennung und Diagnose der Schadorganismen und der typischen Befallssymptome stehen die wirtschaftliche Bedeutung, die Biologie, die Prognose und die verschiedenen Möglichkeiten der Bekämpfung, insbesondere unter Beachtung von Bekämpfungs- und Schadensschwellen, im Vordergrund.	4 SWS
Prüfung: Klausur (45 Minuten) **Prüfungsvorleistungen:** Teilnahme an Exkursionen und Übungen im Feld **Prüfungsanforderungen:** Kenntnis und Diagnose von Pflanzenkrankheiten und tierischen Schädlingen an Kulturpflanzen des gemäßigten Klimas, ihrer Entwicklungs- und Lebenszyklen im Feld.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Birger Koopmann
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Master: 2
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Module M.Cp.0016: Practical statistics and experimental design in agriculture**	6 C 4 WLH
Learning outcome, core skills: The aim of the course is to familiarize students with the basic concepts of statistics and their application in agricultural science. The second goal is to learn the use of software packages like SAS.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Practical Statistics and Experimental Design in Agriculture (Lecture, Exercise) *Contents*: In the beginning of the course, students are introduced to the basic concepts of statistics like frequency distributions, the normal distribution and hypothesis testing. They are also introduced to software packages like SAS, that are used for the practical exercises. Regression and correlation analysis are then introduced. Different experimental designs like randomized block, latin square, and split plot are described and analyzed by one-way analysis of variance or as factorial experiments. Generalized Linear Models will be used and multivariate data will by analyzed by cluster and principal component methods. A large amount of examples and exercises constitute an important aspect of the course, enabling the students to understand and assimilate the theoretical content. Practical analyses of example data sets also provide the students with the required experience and skills for future statistical tasks in the context of Mastertheses.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Knowledge of the basic concepts of statistics and their application in agricultural science and in the use of software packages like SAS.	6 C

Admission requirements: none	**Recommended previous knowledge:** Mathematics, statistics
Language: English	**Person responsible for module:** Dr. Christian Kluth
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Additional notes and regulations:
This module and M.Agr.0036 "Methodisches Arbeiten: Versuchsplanung und -auswertung" are mutually exclusive.

Georg-August-Universität Göttingen **Module M.FES.324: Environmental Biotechnology and Forest Genetics**	6 C 4 WLH

Learning outcome, core skills: Basic principles of population genetics are introduced, factors shaping genetic diversity of tropical forest species are discussed with emphasis on the reproduction system of tropical forest plants, and genetic diversity patterns of tropical forest trees are described. Main applications of forest genetics are mentioned: provenance research and tree breeding, genetic implications of forest management, forest reproductive material, and conservation of forest genetic resources.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Tropical Forest Genetics (Lecture)	2 WLH
Course: Environmental Biotechnology (Lecture)	2 WLH
Examination: Oral examination (approx. 15 minutes)	6 C

Examination requirements: Sound knowledge of learning contents, achievement of learning outcomes and proof of aspired core skills.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Ursula Kües
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: cf. examination regulations	**Recommended semester:**
Maximum number of students: not limited	

Georg-August-Universität Göttingen Universität Kassel/Witzenhausen Module M.SIA.A02M: Epidemiology of international and tropical animal infectious diseases	6 C 4 WLH
Learning outcome, core skills: Based on a scientific and practical up-to-date level, students know to evaluate and develop modern and effective livestock hygiene and husbandry concepts and to integrate them into complex quality management programs. Graduates are trained to be competent in implementing and communicating their knowledge in a multidisciplinary occupational setting that establishes epizootic control programs.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Epidemiology of international and tropical animal infectious diseases (Lecture, Exercise) *Contents*: Infectious diseases play an enormous role in international animal health control. National health and veterinary authorities, as well as international organizations (WHO, FAO) are very much involved in the surveillance of epidemics and establishment of health and hygiene monitoring programs. These efforts will increase in future, because of a further globalization of international markets, and will require well-educated experts collaborating worldwide in this multidisciplinary field. This module will give a generalized view of current epidemics together with a specialized understanding of infectious diseases and hygienic programs in subtropical and tropical countries. Characteristics of the biology of relevant infectious agents like parasites, fungi and bacteria together with their toxins, viruses, and prions will be presented in detail. Some of these germs included in this unit cause severe zoonotic diseases with a lethal danger for humans. Immunological host-defence mechanisms of wild and domestic farm animals against pathogens will be discussed together with modern strategies of active and passive immunizations. Diagnostic methods presently available and new biotechnological approaches in future assay and vaccine development will be demonstrated. The adaptation of practical health and standardized quality management processes to various animal production systems (ruminants, pigs, poultry) and the corresponding management measurements will be explained. The view will deeply focus on environmental impacts (water, soil, air hygiene), epizootiology and modern tools in epizootiological research. It will include biology and eradication of vectors (insects, ticks) transmitting pathogens of animal and zoonotic diseases, as well as biological and chemical methods for vector control. In the laboratory course, this module will also communicate well-established techniques of microbiological and parasitological diagnostics. Students will be practically trained in classical methods and in modern biochemical, immunological, biotechnological and molecular biological techniques for the detection of infectious agents, toxins and noxious substances. Tissue culture procedures for vaccine or antibody development are also used. Modification of livestock-environment interactions through human management are discussed.	4 WLH
Examination: Oral examination (approx. 90 minutes)	6 C

Examination requirements: Knowledge of current veterinary epidemic and infectious diseases inclusive emerging diseases. Background of hygiene and eradication programs. Profound knowledge in important infectious agents (parasites, fungi, bacteria, viruses) as well as toxins and prions. Skills in immunologic defense mechanisms of wildlife, zoo and domesticated animals in connection with modern active and passive vaccination strategies and biotechnological vaccine development. Knowledge in modern diagnostic tools as well as in biology and control of biological vectors (ticks, midges).	

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge (B.Sc. level) of soil, plant and animal sciences
Language: English	**Person responsible for module:** Prof. Dr. Jens Tetens
Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Additional notes and regulations: Literature: Lecture based materials.

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.A14: Organic livestock farming under temperate conditions**	6 C 4 WLH

Learning outcome, core skills: *Advances in animal nutrition and animal health:* Students get to know scientific tools for quantifying, assessing and evaluating problems within organic livestock production. *Animal welfare :* Students have a basic understanding of animal welfare, familiarize with different organic husbandry systems, practical problems and scientific concepts including how to assess animal welfare both at farm and system level. *Sustainable forage production systems:* Students are able to assess the relationships between sward management and structural (yield, botanical composition) and functional (nutrient efficiency) sward characteristics.	**Workload:** Attendance time: 60 h Self-study time: 120 h

Course: Animal welfare (Lecture) *Contents*: • Principles of animal welfare in relation to organic farming; scientific methods of welfare assessment	1,33 WLH
Course: Advances in animal nutrition and animal health (Lecture) *Contents*: • Organic livestock production in Europe • Possibilities and limitations within organic farming to ensure a high level of animal health • Strategies within animal nutrition to increase the efficiency in the use of limited resources • System-oriented versus technical approaches	1,33 WLH
Course: Sustainable forage production systems (Lecture) *Contents*: • Design and management of a sustainable forage production • Management of forage quality and biodiversity on grassland • Minimizing nutrient losses towards water and atmosphere	1,33 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Knowledge of basic terms relevant to organic livestock systems; insights into aspects of feeding, healthcare, welfare, forage production and forage quality assessment; linkages and interdependencies between the discussed fields. One written exam with all three parts.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge (B.Sc. level) of animal sciences
Language: English	**Person responsible for module:** Dr. Margret Krieger
Course frequency: each summer semester; Witzenhausen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 35	

Additional notes and regulations:

Literature:

Advances in animal nutrition and animal health:

- Vaarst, M., Roderick, S., Lund, V., Lockeretz, W. (eds.) 2004: Animal health and welfare in organic agriculture. CABI Publishing

Animal welfare:

- Appleby, M.C., Hughes, B.O. (eds) 1997: Animal welfare. CAB International, Wallingford;
- Vaarst, M. et al. (eds.) 2004: Animal health and welfare in organic Agriculture. CAB International, Wallingford

Sustainable forage production systems:

- Hopkins, A. 2000: Grass, its production and utilization. Blackwell Science, Oxford, UK;
- Cherney J.H. 1998: Grass for dairy cattl.e CABI Publishing, Exon, UK;
- Frame, J. 1992: Improved Grassland Management. Farming Press Books, Ipswich, UK.

Georg-August-Universität Göttingen Universität Kassel/Witzenhausen Module M.SIA.A15M: Scientific writing in natural sciences	6 C 4 WLH

Learning outcome, core skills: In the course of their study programme, when compiling their MSc thesis and for their further (academic) career, students have to deliver a variety of scientific texts. Therefore, this module aims at presenting and discussing the main principles of such texts. It provides training in how to write different types of essays, abstracts, grant winning proposals and complex texts (chapters) in preparation and writing of the master thesis research. At successful completion of this module, participants will be able to: • differentiate the structure and format of various types of scientific texts; • search scientific literature, set up and manage an electronic literature database and compile reference lists; • write term papers, grant proposals, conference abstracts, and final thesis (chapters); • compile scientific tables and figures and be able to decide which type of data is best expressed in which format; • apply the rules of good scientific practice; • give and receive constructive feedback on scientific texts.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Scientific writing in natural sciences *Contents*: To provide participants with theoretical basics and practice these, the module will offer a mixture of lecture and exercises. Within the course a variety of facets and techniques of scientific writing will be imparted that graduate SIA students should be able to master. Consequently, participants are introduced to scientific literature search and analysis, good scientific practice and how to avoid plagiarism. Additionally, guidelines for creating concise tables and figures are presented. To be prepared for their master thesis work, students will be taught how to write different scientific text documents such as grant proposals and conference abstracts. By reviewing and discussing a scientific article and peer-reviewing an abstract of a fellow student by using an online tool, module participants will train how to give and receive constructive feedback. Finally, students will choose a topic for their term paper (see below) to further apply the newly acquired knowledge.	
Examination: 3 short written assignments (approx. 4 pages, 50%) are to be handed in during the semester and one major text (term paper, approx. 6 pages 50%) is to be submitted at the end of the semester.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of Word (Microsoft or Open Office) and Adobe Acrobat.
Language: English	**Person responsible for module:** Prof. Dr. Eva Schlecht

Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 3
Maximum number of students: 30	

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.E11: Socioeconomics of rural development and food security**	6 C 4 WLH

Learning outcome, core skills: Students learn concepts of development and problem-oriented thinking in a development and food security policy context. The identification of interdisciplinary linkages is trained. Building on case-study analyses, course participants can pinpoint appropriate economic and social policies and assess their impacts. These qualifications can also be transferred to unfamiliar situations.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Socioeconomics of rural development and food security (Lecture) *Contents*: This module provides students with an overview of socioeconomic aspects of hunger, malnutrition, and poverty in developing countries. Apart from more conceptual issues and development theories, policy strategies for sustainable rural development and poverty alleviation are discussed and analyzed. Special emphasis is put on problems in the small farm sector. Empirical examples are used to illustrate the main topics.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Concepts and measurement of hunger, malnutrition, and poverty; classification and evaluation of rural development policies	6 C

Admission requirements: none	**Recommended previous knowledge:** Prior knowledge of microeconomics at the BSc level is useful
Language: English	**Person responsible for module:** Prof. Dr. Liesbeth Colen
Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** until 1
Maximum number of students: 120	

Additional notes and regulations: Literature: Text books, research articles and lecture notes.

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.E13M: Microeconomic theory and quantitative methods of agricultural production**	6 C 4 WLH

Learning outcome, core skills: Microeconomic Theory of Agricultural Production Students are familiar with microeconomic approaches and can apply them to analyze issues related to agriculture and rural development. Quantitative Methods in Agricultural Business Economics Students are familiar with quantitative methods used for the analysis and planning of farms and enterprises in the agricultural sector.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Microeconomic theory of agricultural production (Lecture) *Contents*: Consumer theory, producer theory, markets, monopoly situations, risk and uncertainty, economics of technical change, farm household models, sharecropping contracts.	2 WLH
Course: Quantitative methods in agricultural business economics (Lecture) *Contents*: Budgeting, accounting, annual balance sheets, linear programming, finance, investment analysis.	2 WLH
Examination: Written examination (120 minutes) **Examination requirements:** Consumer theory; producer theory; risk; technological progress; farm household models; budgeting and accounting; linear programming; finance; investment analysis.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Oliver Mußhoff Vanessa Bonke
Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 40	

Additional notes and regulations:

Literature:
Text books, research articles and lecture notes.

After successful conclusion of M.Agr.0060 students can not complete M.SIA.E13M

Georg-August-Universität Göttingen **Universität Kassel/Witzenhausen** **Module M.SIA.I14M: GIS and remote sensing in agriculture**	6 C 4 WLH

Learning outcome, core skills: GIS: A broad overview of basic GIS functions and related background knowledge should enable students to explore GIS-Software for relevant commands and prepare functional strategies for spatial data management and analysis. Lecture and exercise examples have predominantly agricultural reference. Remote Sensing The lecture will introduce physical principles (reflectance, transmittance, and absorption), sensor techniques (passive and active sensors, satellites, field spectrometer) and methods of analysis (calibration, validation) in remote sensing applications. This technical framework is presented using agricultural examples, as e.g. the generation of maps for crop yield and protein, assessment of species composition in mixed vegetation (e.g. grassland), like legume content for a calculation of residual nitrogen and crop rotation effects.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Remote sensing in agriculture (Lecture) *Contents*: The lecture will introduce physical principles (reflectance, transmittance, and absorption), sensor techniques (passive and active sensors, satellites, field spectrometer) and methods of analysis (calibration, validation) in remote sensing applications. This technical framework is presented using agricultural examples, as e.g. the generation of maps for crop yield and protein, assessment of species composition in mixed vegetation (e.g. grassland), like legume content for a calculation of residual nitrogen and crop rotation effects.	2 WLH
Course: GIS (Lecture) *Contents*: The course gives an introduction to Geographical Information Systems (GIS). Starting from geodetical background information, a wide range of different GIS- methods and -functions are presented using agricultural examples (e.g. data import, georeferencing, aggregation, (re)classification, interpolation, overlays and image analysis). The students have the opportunity to carry out exercises on the computer themselves for some important GIS-procedures. A special focus is given on data capturing using maps and field data survey with GPS as well as the spatial analysis of site conditions. Finally a particular view on GIS in organic farm management and Precision Farming is given.	2 WLH
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** Knowledge about basic GIS functions and the preparations of functional strategies for spatial data management. Knowledge of physical principles, methods of analysis and sensor techniques.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Jayan Wijesingha
Course frequency: each winter semester; Witzenhausen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Additional notes and regulations: Literature: Principles of Geographical Information Systems by Peter A. Burrough and Rachael A. McDonnell (2015) Introduction to Remote Sensing by James B. Campbell andRandolph H. Wynne (2011)

Georg-August-Universität Göttingen Universität Kassel/Witzenhausen **Module M.SIA.P13: Agrobiodiversity and plant genetic resources in the tropics**	6 C 4 WLH
Learning outcome, core skills: Students are able to understand the role of agrobiodiversity in tropical agro-ecosystems, to present approaches of functional biodiversity analysis and to discuss the needs and strategies of on-farm (in situ) and off-farm conservation of plant genetic resources.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Agrobiodiversity and plant genetic resources in the tropics (Lecture, Seminar) *Contents*: Case-study based analysis of the role of biodiversity for selected crops in different agroecosystems from the arid to the humid climate zones; importance of biodiversity for the stability / sustainability of smallholder (subsistence) versus commodity-oriented commercial agriculture in the Tropics, assessment and utilization of diversity, principles and practices in conservation of genetic resources, role of homegardens and indigenous wild fruit trees for in situ conservation of biodiversity, causes and consequences of genetic erosion, approaches of germplasm collection.	4 WLH
Examination: Oral exam (about 15 minutes, 60%) and presentation (about 20 minutes, 40%) **Examination requirements:** Students should be able to understand the role of agrobiodiversity in tropical agroecosystems, to present basic approaches to functionally analyse biodiversity and to discuss the need of and strategies for in and ex situ conservation of genetic resources.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge in plant and soil sciences
Language: English	**Person responsible for module:** Prof. Dr. Gunter Backes
Course frequency: each winter semester; Witzenhausen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: not limited	

Additional notes and regulations:
Literature:
Altieri, M. 1987: Agroecology: the scientific basis of alternative agriculture. Westview Press, Boulder, Colorado, USA; Eyzaguirre, P.B., Linares, O.F. 2004: Home gardens and agrobiodiversity. Smithsonia Books, Washington, USA; Wood, D., Lenne, J.M. 1999: Agrobiodiversity: Characterization, utilization and

management. CABI Publishing, Wallingford, UK.

Georg-August-Universität Göttingen **Module M.iPAB.0001: Quantitative genetics and population genetics**	6 C 6 WLH
Learning outcome, core skills: Advanced knowledge of the basic model of quantitative genetics, genetic effects and parameters, breeding values and variances. Similarity between relatives, inbreeding, crossbreeding and heterosis. Dynamics of genetic variability in limited populations.	**Workload:** Attendance time: 84 h Self-study time: 96 h
Course: Quantitative genetics and population genetics (Lecture, Exercise) *Contents*: The genetic composition of a population in a single locus model, changes of gene and genotype frequencies, the polygenic model, components of phenotypic variance, relationship and inbreeding, heterosis and inbreeding depression, genetic drift, linkage disequilibrium, selection signatures. All contents are initially taught in theory and are consolidated in practical computer exercises (some with real data). Literature: Falconer & Mackay, Introduction to Quantitative Genetics (Prentice Hall), Lynch and Walsh, Genetics and Analysis of Quantitative Traits (Sinauer)	6 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Advanced knowledge of the quantitative-genetic and population genetic basics of breeding, ability to apply appropriate methods to real data sets. Final exam with practical examination on computer.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of plant and animal breeding
Language: English	**Person responsible for module:** Prof. Dr. Ahmad-Reza Sharifi
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0002: Breeding schemes and programs in plant and animal breeding**	6 C 4 WLH
Learning outcome, core skills: Students will learn the basic elements and structures of breeding programs in plant and animal breeding. They understand the relationship between biological characteristics of the crop or livestock species and the specific design of the breeding program. The students know the four breeding categories and design possibilities of breeding programs for self-pollination, cross-pollination and vegetative and clonally propagated crops. They learn breeding programs for major crops and livestock species.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Breeding schemes and programs in plant and animal breeding (Lecture, Excursion) *Contents*: Design of breeding programs. Basic elements of breeding programs: Breeding objectives and breeding planning, performance testing, selection and mate selection, use of biotechnologies, transfer of breeding progress in the production level, monitoring of the breeding progress. Breeding program structures in the most important crop species: cereals, corn, rape, sugar beet, specialty crops. Breeding program structures in the main livestock species: dairy cattle, pigs, poultry, beef cattle, small ruminants. Breeding program structures in forest genetics.	4 WLH
Examination: Written exam (45 minutes, 50%) and an Essay (45 minutes, 50%) **Examination requirements:** Profound knowledge of basic breeding program structures and elements of breeding programs and their concrete implementation to various crops and livestock. Elaboration of the breeding planning for a livestock or crop species.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Birgit Jutta Zumbach
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1
Maximum number of students: 30	

Additional notes and regulations:
Mandatory excursions to practical plant breeding and animal breeding programs.

Georg-August-Universität Göttingen **Module M.iPAB.0003: Statistical genetics, breeding informatics and experimental design**	6 C 4 WLH
Learning outcome, core skills: Novel biotechnological methods allow the production of very large data sets (gene sequences, genotypes, transcriptomes) at decreasing costs. Students learn about statistical and computational methods to use these records for breeding issues. Furthermore, the main experimental designs to plan, implement, and evaluate targeted and efficient experiments for data generation will be treated.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Statistical genetics, breeding informatics and experimental design (Lecture, Exercise) *Contents*: • Gene Expression Analysis • Genome-wide association analysis • QTL mapping • Statistical hypothesis testing • Regression methods • Analysis of variance • Multiple testing • Experimental designs (block designs, randomized designs, Latin squares) • Sample size estimation • Introduction to programming • Fundamentals of databases Literature: Andrea Foulkes: Applied Statistical Genetics with R	4 WLH
Examination: Written examination (60 minutes) **Examination requirements:** Profound knowledge of statistics and informatics methods to use them for breeding issues.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basics in statistics and genetics
Language: English	**Person responsible for module:** Prof. Dr. Armin Schmitt
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0004: Internship**	9 C 6 WLH

Learning outcome, core skills: Specialized knowledge of the respective field, social competences (working organization, teamwork, interdisciplinary working, flexibility), applied methodical competences.	**Workload:** Attendance time: 240 h Self-study time: 30 h

Course: Internship (Internship) *Contents*: Practical working in different areas of plant and animal breeding (industry, departmental research, consulting). Insights to working methods, areas of responsibility and the everyday professional life in plant and animal breeding. Acquisition of practical and applied knowledge and skills. Duration of Internship: 6 weeks	6 WLH
Examination: Term paper (max. 20 pages, 50%) and presentation (approx. 20 minutes, 50%), not graded **Examination requirements:** Practical working in different areas of plant and animal breeding, internship report and presentation.	9 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Scholten
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen Module M.iPAB.0005: Poultry breeding and genetics	6 C 4 WLH
Learning outcome, core skills: The module teaches substantiated and application-orientated understandings of the poultry breeding sector. The main organizational and technological elements of the current breeding programs as well as their optimization to future breeding challenges will be provided. Thereby, breeding strategies of relevant economic traits will be shown concentrating on the development of selection strategies to improve functional traits (adaption to climate, disease resistance, behavior, reproduction, product quality, metabolic dysfunction). Students will learn the application of quantitative and molecular genetic technologies for the applied research in poultry breeding.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Poultry breeding and genetics (Lecture, Excursion) *Contents*: • Structure, Organization and Economics of Poultry Breeding • Breeding Strategies for primary and functional traits in poultry and water fowl (genetics and breeding in reproduction, feed conversion, growth, product quality, immune system, disease resistance, behavior and well-being, environmentaladaption and metabolic stability). This includes particularly: • Methods of phenotyping and performance testing • Estimation of breeding values (conventional and genomic) • Selection index and BLUP • Genome-wide association studies (GWAS) and QTL mapping • Omics • Software application	4 WLH
Examination: Written examination (90 minutes) **Examination prerequisites:** Attendance to the mandatory excursion **Examination requirements:** Profound knowledge about applied poultry breeding.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basics of animal breeding
Language: English	**Person responsible for module:** Prof. Dr. Ahmad-Reza Sharifi
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Additional notes and regulations:
Attendance to the mandatory excursion.

Georg-August-Universität Göttingen Module M.iPAB.0006: Breeding informatics	6 C 4 WLH
Learning outcome, core skills: Students acquire their knowledge of informatics methods to evaluate large datasets for breeding issues.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Breeding informatics (Lecture, Exercise) *Contents*: • Bascics of Linux operating system • Basic data structures • Programming in R • Regular expressions • Design and implementation of pipelines for data analysis • Shell scripts on Linux (gawk, sed) • Relation of genotype - phenotype • Basic concepts of bioinformatics	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Profound knowledge of informatics methods to evaluate large datasets for breeding issues.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of molecular genetics, statistics, programing
Language: English	**Person responsible for module:** Prof. Dr. Armin Schmitt
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0007: Biotechnology and molecular genetics in plant and animal breeding**	6 C 4 WLH
Learning outcome, core skills: Profound knowledge of biotechnologies to decipher phenotypes and traits for plant and animal breeding. Skills to use appropriate molecular genetic tools to elucidate the genetic basis of traits. Development of creativity and independent as well as globally thinking to solve complex breeding challenges; effective communication skills (both orally and written); self-learners.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Biotechnology and molecular genetics in plant and animal breeding (Lecture, Excursion) *Contents*: Basics of genetics (Mendelian inheritance; karyograms; DNA, RNA and protein; gene structure; epigenetics), Biotechnologies for animal breeding (Artificial Insemination; Spermsexing; embryo transfer and associated techniques such as in vitro fertilization, embryo sexing, stem cells, cloning), Biotechnologies for plant breeding (in vitro cloning, induction of haploids, direct and indirect genetic transformation, interspecific sexual and somatic hybridization), Molecular genetics (PCR; qPCR; Recombinant DNA Technology; DNA markers; miRNA; Sanger sequencing; expression analysis; Next Generation Sequencing; array techniques; cytogenetics; proteomics; genome editing techniques). Literature: Clark & Pazdernik: Biotechnology (Academic Cell Publishing); Pineda & Dooley: Veterinary Endocrinology and Reproduction (Blackwell Publishing); Squires: Applied Animal Endocrinology (CABI); Krebs, Kirkpatrick, Goldstein: Lewin’s Gene XI (Jones and Bartlett Publishing); Brown: Gene cloning and DNA analysis (Blackwell Science); Journal: Trends in Plant Science (Elsevier Ltd.)	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** The examinee should show the potential to solve breeding challenges applying the best biotechnologies and most accurate molecular genetic tools.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basics in animal and plant breeding
Language: English	**Person responsible for module:** Prof. Dr. Jens Tetens
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0008: Molecular and biotechnological methods in plant and animal breeding**	6 C 4 WLH

Learning outcome, core skills: In addition to the theoretical background (Module M.Agr.0131 (Biotechnology and molecular genetics in plant and animal breeding)), the students should improve their basic knowledge in biotechnologies and molecular genetics by learning hand-on skills in the lab. The students should be capable to perform experiments on their own and to present them in an adequate manner.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Molecular and biotechnological methods in plant and animal breeding (Block course, Practical course) *Contents*: Sample collection; DNA and RNA isolation; Sanger Sequencing including the usage of appropriate software programs; Separation and visualization of nucleic acids; qualitative and quantitative PCR; ELISA assays to determine hormone profiles or as a pregnancy/ non pregnancy testing system; microsatellites; SNP; AFLP; storage of DNA and RNA; semen evaluation; in vitro generation and genetic analyses of embryos; direct and indirect transformation; protoplasts, in vitro propagation, androgenesis and gynogenesis; gene cloning. Literature: e.g. Current Protocols in molecular biology; A practical guide to basic laboratory endocrinology: Introduction to Plant Biotechnology	4 WLH
Examination: Term paper (max. 40 pages, 80%) and presentation (about 10 minutes, 20%) **Examination prerequisites:** M.iPAB.0007 Biotechnology and molecular genetics in plant and animal breeding or M.Agr.0131 Biotechnology and molecular genetics in plant and animal breedin **Examination requirements:** The examinees should provide detailed information in their term paper (writen as protocols) including the biological background of the methods. The examinee should show its independent ability to conduct experiments in the lab.	6 C

Admission requirements: M.iPAB.0007 M.iPAB.0007 Biotechnology and molecular genetics in plant and animal breeding or M.Agr.0131 Biotechnology and molecular genetics in plant and animal breeding	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Jens Tetens
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

twice	Master: 2
Maximum number of students: 20	

Georg-August-Universität Göttingen Module M.iPAB.0009: Genetic resources	6 C 4 WLH
Learning outcome, core skills: Students learn the value of genetic resources for crop and livestock and know the history, political meaning and the institutions of the global system for the conservation of plant and animal genetic resources. They know methods for molecular and phenotypic characterization, and different statistical methods to evaluate and quantify genetic diversity. The students are familiar with different technological approaches (in vivo, in vitro) for the conservation and management of genetic resources. They know principles for prioritization in the conservation of genetic resources and can apply them to a practical example. The students understand principles and methods for the utilization of genetic resources in breeding programs.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Genetic resources (Lecture, Seminar) *Contents*: Definition of genetic resources and gene pools at different hierarchical levels. Centers of diversity and domestication, concepts of conservation. Methods for molecular and phenotypic characterization in plants and animals. Crossability, genetic differentiation and adaptation of plant and animal genetic resources. Measures of genomic diversity within and between animal populations. Wright's F-statistics, genetic distances and different approaches of cluster analyses, principal component analysis, phylogenetic trees and model-based clustering. Prioritization for conservation. Implementation of analytical methods with appropriate software. Utilization of genetic resources in breeding programs, cross breeding and introgression via breeding or molecular introgression. *Mandatory excursion to the gene bank at Gatersleben* *Mandatory excursion to the German gene bank of farm animals at FLI-ING Mariensee* *Literature:* FAO (2015) The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture	4 WLH
Examination: seminar presentation (about 20 minutes, 50%), written report based on seminar contents (max 10 pages, 50%) **Examination requirements:** Presentation of an overview of genetic resources and their use in a livestock or crop species. Profound knowledge of the underlying principles and methodological approaches to assess, conserve, prioritize and use genetic diversity in crops and livestock. items to be covered: • centre of origin/centre of diversity • genepool concept for the crop/livestock • international/regional impact and use • status of conservation • Status of genome research and analysis of diversity • any other aspect of interest	6 C

Admission requirements: none	**Recommended previous knowledge:** Basics of plant and animal breeding, Molecular Genetics
Language: English	**Person responsible for module:** Prof. Dr. Nils Stein
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0010: Legal Issues in Plant and Animal Breeding: Intellectual Property Protection, Welfare and Global Trade**	3 C 2 WLH
Learning outcome, core skills: The students know the relevant laws, regulations and procedures for plant and animal breeding in the areas of patent law, plant variety rights, plant variety protection, animal breeding, animal protection. Students know the legal basis for genetically modified organisms in the EU and globally. The students gain a deeper understanding of the importance of legal issues in breeding.	**Workload:** Attendance time: 26 h Self-study time: 64 h
Course: Legal issues in plant and animal breeding (Lecture, Seminar) *Contents*: Legal issues in plant and animal breeding (Lecture and Seminar) Contents: International intellectual property rights, biological patents, agreements on genetic resources, GMO laws and regulations incl. The preparatory phase of European legislation for modern biological breeding tools for genome editing. In terms of plant breeding, the module covers the following topics: plant breeders 'rights, European and German breeders' rights and marketing rights for seeds including procedures for testing and acceptance of varieties and operating license obtained seed. Regarding the animal breeding, the module covers the following topics: German animal breeding law, European legal framework, animal breeding related aspects of animal welfare legislation, legal regulations on animal testing, legal regulations of international trade with breeding animals and breeding products. Literature: Plant Variety Protection Law, Animal Breeding Law, Patent Law, regulation on genetically modified food and feed	2 WLH
Examination: Written examination (45 minutes) **Examination requirements:** Profound knowledge of all aspects of the legal basis of plant and animal breeding. Preparation of a case study on legal issues.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Ahmad-Reza Sharifi
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.iPAB.0012: Journal Club: Key papers in animal and plant breeding**	6 C 4 WLH
Learning outcome, core skills: Students gain competences in the opening and discussion of a scientific topic by using the literature in the field of plant and animal breeding. They also obtain skills in oral and written presentation of their investigation.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Journal Club: Key papers in animal and plant breeding (Lecture, Seminar) *Contents*: Teaching of methods for collecting and using of scientific contents and papers for a specific topic. Ability to discuss scientific texts in a deepened substantive way on the basis of a comprehensive literature review.	4 WLH
Examination: Presentation (about 20 minutes) with written outline (max. 10 pages) **Examination prerequisites:** Regular participation in 10 seminars **Examination requirements:** Preparation of a literature based seminar presentation including discussion and a short draft, preparation of a co-moderation and discussion leading, attendance to seminars.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Alexander Charles Mott
Course frequency: each semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen Module M.iPAB.0014: Data Analysis with R	3 C 2 WLH
Learning outcome, core skills: The students will be able to use methods provided by the statistical package R to perform the analysis of data sets that are typical in the life sciences. A core skill is the identification, usage and evaluation of online resources (e.g. packages and data sets).	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Data Analysis with R (Block course, Lecture, Exercise) *Contents*: The fundamental concepts of the programming package R will be presented and deepened during practical exercises. Statistical methods will be recapitulated if necessary. Special emphasis is put on visualization methods. Literature: Wiki-book "R programming" https://en.wikibooks.org/wiki/R_Programming "R for Beginners" by Emanuel Paradis https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf "R tips" by Paul E. Johnson http://pj.freefaculty.org/R/Rtips.pdf	2 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Ability to analyze typical data sets with the statistical package R and interpretation of the results.	3 C

Admission requirements: none	**Recommended previous knowledge:** Knowledge of basic statistics concepts
Language: English	**Person responsible for module:** Thomas Martin Lange
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 4
Maximum number of students: 24	

Georg-August-Universität Göttingen **Module M.iPAB.0015: Applied Machine Learning in Agriculture with R**	6 C 4 WLH

Learning outcome, core skills: Modern agricultural research involves more and more the analysis of large datasets comprising mesaurements of several variables. This module aims to teach interested students fundamental analysis skills that permit them to cope with such data sets. In more detail, the techniques that will be treated include: • clustering • artificial neural networks • support vector machine • decision trees • random forests • feature selection Involved mathematical formalism will be avoided. The focus is rather on: • gaining an intuitive understanding of the techniques • to develop an understanding about which type of problem can be treated with which technique • the application of the techniques using machine learning-functions under R • the graphical visualisation of the results • and the interpretation of the results The teaching will be based on the analysis of published real data sets from agricultural research projects as far as possible.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Applied Machine Learning in Agriculture with R (Block course) *Contents*: The course consists of lectures, exercises and project work. After the lectures and the exercises the students will have to carry out a project work that must be finished within eight weeks after the end of the lectures. The students as well as the other research groups are welcome to suggest topics, possibly questions related to their master thesis can be treated. The project work should be a concise written report of about ten pages in which one or several of the techniques that were treated in the course are applied.	4 WLH
Examination: Oral examination (approx. 20 minutes, 60%) and term paper (max. 10 pages, 40%) **Examination requirements:** • Knowledge about the analysis of big-data sets with the statistical package R and interpretation of the results. • Knowledge about different clustering algorithms • Analysis of real agricultural data sets by applying different machine learning-functions under R • Knowledge about feature selection approaches	6 C

Admission requirements: Recommended previous knowledge: Basic knowledge of R	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Felix Heinrich
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.iPAB.0016: Applied effective R programming in animal breeding and genetics**	3 C 2 WLH
Learning outcome, core skills: The students will be able to efficiently use the programing language R on big animal datasets and to implement automated workflows for animal data analysis. They also will be enabled to distribute their implementations to end users.	**Workload:** Attendance time: 28 h Self-study time: 62 h
Course: Applied effective R programming in animal breeding and genetics (Lecture, Exercise) *Contents*: Effective usage of the programming language R applied to animal breeding and genetics examples. This includes detailed knowledge about the use of different data types and objects in R, automation and optimization of workflows, connection to third party software. • Data input/ output • Matrix algebra in R • Effective data management • Profiling/ Benchmarking • String modifications • Parallelization • Running self-executable R scripts via the command line	2 WLH
Examination: Term paper (max. 30 pages) (max. 30 pages) **Examination prerequisites:** Regular attendance of course **Examination requirements:** The term paper must include the code; self-executable application for a predefined task with focus on efficiency and usability, short description on how the task was solved.	3 C

Admission requirements: Basic knowledge of the programming language R, for example proven by the successful participation in the modules • M.Agr.0141: Data Analysis with R • B.Agr.0375: Bioinformatik • B.Agr.0308: Biometrie or comparable modules or proofs of knowledge.	**Recommended previous knowledge:** Basic command of R
Language: English	**Person responsible for module:** N. N.
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

twice	Master: 2
Maximum number of students: 30	

Additional notes and regulations: EMABG students will be taken preferred before all others. iPAB and M.Agr. Animal Science before others.

Georg-August-Universität Göttingen **Module M.iPAB.0018: Introduction to the molecular genetic analysis of plant genetic resources**	6 C 4 WLH
Learning outcome, core skills: Students apply knowledge acquired in Module M.Agr.0133: Genetic Resources (GenRes). They have a broad overview of available molecular marker technologies for characterisation and quality management of GenRes. They familiarize by own hands-on experience with next-generation-sequencing based characterization of plant genetic resources. They apply computational tools for raw data acquisition and perform basic analytical steps in population characterization, genetic diversity analysis and/or genetic mapping.	**Workload:** Attendance time: 56 h Self-study time: 124 h
Course: Introduction to the molecular genetic analysis of plant genetic resources (Block course, Excursion, Seminar) *Contents*: Introduction into Molecular Marker and Next Generation Sequencing Technologies: principle of methodology, sample preparation requirements, infrastructure requirements for data storage and analysis. Wet lab experiments (performed in teams of two at IPK): NGS library preparation, NGS sequencing and data acquisition. Data analysis experiments 1. individually and as a team, at IPK: existing training datasets will be used for performing basic steps of raw data processing and downstream data analysis (read mapping, SNV calling, allele frequency test, mapping, GWAS, PCA) 2. group work/homework: NGS samples processed during the practical course will be analysed in team work by the participants based on the acquired knowledge. Results will be presented and discussed during the literature seminar day at GAU. Literature seminar: every participant will select an original paper on the topic during the course and present a seminar to the group at a later timepoint during the same semester. Excursion to IPK Genebank: this excursion to IPK will give insights into in field collection management during replication cycles for self-, cross-pollinating crops or vegetatively propagated species including practices of acquisition of legacy data. *Literature:* FAO (2015) The Second Report on the State of the World’s Animal Genetic Resources for Food and Agriculture;	4 WLH
Examination: Written report (max. 10 pages, 50%) and presentation (approx. 20 minutes; 50 %) **Examination requirements:** Submission of written reports (lab protocols and analysis results); knowledge of molecular marker and NGS technology for collection characterisation and management	6 C

Admission requirements:	**Recommended previous knowledge:**

M.Agr.0133	Basics of plant and animal breeding, Molecular Genetics
Language: English	**Person responsible for module:** Prof. Dr. Nils Stein
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 10	

Georg-August-Universität Göttingen **Module M.iPAB.0019: Scientific Project: scientific methods, procedures and practical skills in animal and plant breeding**	9 C 6 WLH
Learning outcome, core skills: Advanced knowledge of scientific methods, procedures and practical skills in the field of animal as well as plant breeding acquired by the active participation in a research project. Students also gain key competencies such as team working, interdisciplinary working, and self-organization.	**Workload:** Attendance time: 60 h Self-study time: 210 h
Course: Scientific Project: scientific methods, procedures and practical skills in animal and plant breeding *Contents*: Working on a scientific project in the different fields of breeding research. Testing of scientific hypotheses, experimental design, analysis of genotyping data, data analysis, interpretation and presentation of the research results.	6 WLH
Examination: Term paper (max. 20 pages) **Examination requirements:** Active and independent working on a plant or animal breeding related scientific issue.	9 C

Admission requirements: The students, who are enrolled in the “Integrated plant and animal breeding (IPAB)” program, must get an approval from the program coordinator at least one month prior to the desired start date of the project.	**Recommended previous knowledge:** Basics of plant and animal breeding, statistics, and scientific writing
Language: English	**Person responsible for module:** Thomas Martin Lange
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Georg-August-Universität Göttingen **Module M.iPAB.0020: Breeding Lab Internship**	9 C
Learning outcome, core skills: Students acquire professional and social skills to successfully execute a team project in complex international animal breeding business conditions. Students gather, select, and analyze information and integrate it into a viable R&D proposition, aimed at value creation. Students attain the ability to systematically evaluate information following a systematic structure, as well as take complexity (such as cultural and social awareness) into account during decision making. Furthermore, students practice professional behavior and habitus in a competitive international environment. They are able to discuss and defend their viewpoints and conclusions in a professional and academically correct way before industry representatives.	**Workload:** Attendance time: 160 h Self-study time: 110 h
Course: Breeding Lab Internship (Internship, Seminar) *Contents*: Management structures, communication and collaboration techniques when working in diverse groups, conflict management, product concept development, industry methods and practices, as well as insights into areas of responsibility and the everyday professional life of an animal breeder. Students experience a specialized animal breeding working environment outside of a university setting. Placement in non-university setting approx.4 weeks	
Examination: Presentation (approx. 15 minutes, 50%) with written report (max. 15 pages, 50%), not graded **Examination prerequisites:** Practical work in non-university animal breeding field. Regular attendance during the four weeks. **Examination requirements:** Reflection on learning outcomes and personal experiences, as well as problem-solving capabilities and working in a diverse group outside of a university setting.	9 C

Admission requirements: Only EMABG Students	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Ahmad-Reza Sharifi
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** from 1
Maximum number of students: 20	

Additional notes and regulations:

Students are present approx. 4 weeks at an associated partner (non-university organization) to gain insights and establish contact regarding R&D proposition. The students have extended time (approx. 4 weeks) to work on their project upon leaving the associated partner. Whenever possible, the result will be presented to and co-graded by a representative from the associated partner.

<table>
<tr><td>Georg-August-Universität Göttingen
Module M.iPAB.0021: Plant in vitro Cultures and Somatic Cell Genetics</td><td>6 C
4 WLH</td></tr>
<tr><td>Learning outcome, core skills:
The students are able to plan and perform plant bio- and gene-technological procedures independently and to assess their suitability for breeding related questions considering scientific and economic issues.</td><td>Workload:
Attendance time:
56 h
Self-study time:
124 h</td></tr>
<tr><td>Course: Plant in vitro Cultures and Somatic Cell Genetics (Block course, Lecture, Exercise)
Contents:
Lecture Contents
• Overview on bio- and gene-technological methods
• Theoretical basis, genetics and epigenetics of plant tissue culture methods
• Focus on Somatic Hybridization-, Doubled-Haploid- and Genome Editing-related plant tissue culture technology
• Methodology and strategies in genome editing and its verification
• Applications in applied breeding and plant research
• Scientific standards of lab work documentation

Practical Contents
• Design and cloning of gene specific guide-RNA
• Protoplast fusion and transformation
• Mutation detection and analysis
• Biolistic Transformation
• Embryo rescue and germination

Basics and context of biotechnological practical work by means of discrete, consecutive project work on CRISPR/Cas9 based genome editing including vector design, cloning and activity validation. The project sequence includes:
• In silico design of gene specific guide RNA
• Cloning of CRISPR/Cas9 vectors
• Transient transformation of the vectors in protoplasts
• Determination of the mutation efficiency by endonuclease assays</td><td></td></tr>
<tr><td>Examination: Protocol (max. 25 pages, 70%) and oral examination (approx. 15 min., 30%).
Examination requirements:
Regular attendance of practical (minimum of 90%).

Formal protocol with scientifically sound lab work documentation including introduction, methods, results and discussion.

Knowledge on practical implementation, execution and applicability of molecular and cell culture methods in research and breeding</td><td>6 C</td></tr>
</table>

Admission requirements: none	**Recommended previous knowledge:** Units of applied molecular biology and its conversion
Language: English	**Person responsible for module:** Prof. Dr. Stefan Scholten
Course frequency: each summer semester	**Duration:**
Number of repeat examinations permitted: twice	**Recommended semester:** until 3
Maximum number of students: 12	

Georg-August-Universität Göttingen **Module M.iPAB.0022: Molecular Genetics and Genomics**	6 C 4 WLH
Learning outcome, core skills: The students are able to plan and perform complex molecular techniques independently and to assess their suitability for breeding related questions considering scientific and economic factors.	**Workload:** Attendance time: 80 h Self-study time: 100 h
Course: Molecular Genetics and Genomics (Block course, Lecture, Exercise) *Contents*: *Lecture Contents* • Overview on molecular methods in gene and genome analysis • Theoretical basis of classical and new marker technologies • Methodology, areas of use, and automation of sequencing technologies • Applications in applied breeding and breeding research *Practical Contents* Basics of molecular biology practical work with nucleic acids by means of discrete performing polymerase chain reactions (PCR), short sequence repeats (SSR) and single nucleotide polymorphism (SNP) marker protocols. Robotics for high-throughput and miniaturization of molecular biology methods by means of using pipetting robots for single steps of the custom procedures. Custom procedures for genome and transcriptome analysis: • Production of sequencing libraries for genotyping DNA by sequencing (GBS). • Production of sequencing libraries for strand specific 3’ targeted gene expression analysis by Digital Gene Expression RNA sequencing (3’ DGE RNA-seq).	
Examination: Protocol (max. 25 pages, 70%) and oral examination (approx. 15 min., 30%) **Examination requirements:** Regular attendance of practical (minimum of 90%). Formal protocol with scientifically sound lab work documentation including introduction, methods, results and discussion. Knowledge on practical implementation, execution and applicability of molecular marker and sequencing technology in research and breeding	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Scholten
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

twice	
Maximum number of students: 12	

Georg-August-Universität Göttingen **Modul M.iPAB.0023: Journal Club: Evolutionary Genetics and Breeding** *English title: Journal Club: Evolutionary Genetics and Breeding*	3 C 2 SWS
Lernziele/Kompetenzen: Students gain competences in comprehension and discussion of scientific topics by critically reading published literature in the field of evolutionary genetics and breeding. They also obtain skills in oral and written presentation of their investigation	**Arbeitsaufwand:** Präsenzzeit: 26 Stunden Selbststudium: 64 Stunden
Lehrveranstaltung: Journal Club: Evolutionary Genetics and Breeding (Vorlesung, Seminar) *Inhalte*: Teaching of methods for collecting and using of scientific contents and papers for a specific topic. Ability to discuss scientific texts in a deepened substantive way on the basis of a comprehensive literature review.	2 SWS
Prüfung: Active participation and consistent attendance, unbenotet **Prüfungsvorleistungen:** Regular reading of the assigned literature in advance of the weekly course meetings **Prüfungsanforderungen:** Regular and meaningful contributions to the group discussion. Demonstration of critical thinking via postulating valuable questions that demonstrate comprehension of the assigned literature.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Dr. Birgit Jutta Zumbach
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Fakultät für Agrarwissenschaften:

Nach dem Beschluss des Fakultätsrats der Fakultät für Agrarwissenschaften vom 21.12.2023 hat das Präsidium der Georg-August-Universität Göttingen am 31.01.2024 die Neufassung des Modulverzeichnisses zur Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang „Pferdewissenschaften" genehmigt (§ 44 Abs. 1 Satz 2 NHG, §§ 37 Abs. 1 Satz 3 Nr. 5 b), 44 Abs. 1 Satz 3 NHG).

Georg-August-Universität
Göttingen

Modulverzeichnis

für den konsekutiven Master-Studiengang "Pferdewissenschaften" - zu Anlage 4 der Prüfungs- und Studienordnung für Master-Studiengänge der Fakultät für Agrarwissenschaften (Amtliche Mitteilungen I Nr. 26/2023 S. 869)

Module

Übersicht nach Modulgruppen

I. Master-Studiengang "Pferdewissenschaften"

Es müssen Leistungen im Umfang von insgesamt wenigstens 120 C erfolgreich absolviert werden.

1. Block A (Fachstudium - Pflichtmodule)

Es müssen die folgenden fünf Pflichtmodule im Umfang von insgesamt 30 C erfolgreich absolviert werden:

2. Block B (Fachstudium - Wahlpflichtmodule)

Es müssen 3 der folgenden Wahlpflichtmodule im Umfang von insgesamt 18 C erfolgreich absolviert werden.

3. Block C (Professionalisierungsbereich)

Es müssen Schlüsselkompetenzmodule im Umfang von insgesamt wenigstens 12 C nach Maßgabe der nachfolgenden Bestimmungen erfolgreich absolviert werden.

a. Pflichtmodule

Es muss folgendes Modul im Umfang von 6 C erfolgreich absolviert werden:

b. Wahlpflichtmodule

Es muss eines der folgenden Module im Umfang von 6 C erfolgreich absolviert werden.

4. Block D

Ferner müssen weitere fünf Wahlpflichtmodule im Umfang von 30 C aus dem Angebot dieses oder eines anderen agrarwissenschaftlichen Master-Studiengangs erfolgreich absolviert werden.

5. Masterarbeit

Durch die erfolgreiche Anfertigung der Masterarbeit werden 24 C erworben.

6. Kolloquium zur Masterarbeit

Durch das erfolgreiche Absolvieren des Kolloquiums zur Masterarbeit werden 6 C erworben.

Georg-August-Universität Göttingen **Modul M.Agr.0012: Empirische Methoden: Marktforschung und Verbraucherverhalten** *English title: Empirical Methods: Market Research and Consumer Behavior*	6 C (Anteil SK: 6 C) 4 SWS
Lernziele/Kompetenzen: Die Studierenden sind in der Lage, nach Abschluss dieses Moduls eigenständig ein empirisches Projekt von der Zieldefinition über die Erarbeitung des theoriegestützten Untersuchungsmodells bis zur Datenanalyse und -präsentation durchzuführen. Dies befähigt sie nicht nur für die entsprechenden Berufsfelder im Agrarmarketing, sondern liefert auch wichtige Grundlagen für empirische M.Sc.-Arbeiten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Empirische Methoden: Marktforschung und Verbraucherverhalten (Seminar) *Inhalte*: Vertiefte Veranstaltung zu den wichtigsten Erhebungs- und Analysemethoden der empirischen Marktforschung und den theoretischen Grundlagen der Käuferanalyse. Im theoretischen Teil wird die Konsumforschung als interdisziplinäre Forschungsdisziplin vorgestellt (Ökonomie, Psychologie, Soziologie, experimentelle Forschung). Im Marktforschungsteil werden die zentralen quantitativen und qualitativen Erhebungsmethoden vorgestellt. Im Anschluss erfolgt eine rechnergestützte Einführung in die modernen Verfahren der uni-, bi- und multivariaten Datenanalyse. Abschließend wird die Anwendung und Präsentation von Marktforschungsergebnissen behandelt.	4 SWS
Prüfung: Hausarbeit (max. 40 Seiten, 50%) und Präsentation (ca. 20 Minuten, 50%) (90 Minuten) **Prüfungsvorleistungen:** Erstellung eines Berichts (max. 10 Seiten, unbenotet) **Prüfungsanforderungen:** Prüfungsanforderungen sind dezidierte Kenntnisse der Theorien des Käuferverhaltens (insb.ökonomische Ansätze, psychologische Theorien, soziologische Theorien), qualitative Methoden, univariate statistische Verfahren der empirischen Sozialforschung, bivariate Verfahren, ausgewählte multivariate Verfahren (Faktorenanalyse, Clusteranalyse, Regressionsanalyse) Zur Teilnahme an der Klausur berechtigt sind jene Studierenden, die im Zuge des Moduls an der Erstellung eines wissenschaftlichen Berichtes beteiligt waren. Der Bericht umfasst eine empirische Auswertung von modulspezifischen Daten und wird innerhalb des Seminars angeleitet.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Achim Spiller
Angebotshäufigkeit:	**Dauer:**

jedes Sommersemester	1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**

Georg-August-Universität Göttingen **Modul M.Agr.0036: Methodisches Arbeiten: Versuchsplanung und -auswertung** *English title: Methods of Scientific Presentation: Experiment Planning and Evaluation*	6 C (Anteil SK: 6 C) 4 SWS
Lernziele/Kompetenzen: Studierende erlernen Grundlagen der statischen Versuchsauswertung auf praktische Beispiele anzuwenden und fundierte Entscheidungen zur Aussagekraft der Versuche zu fällen. Die Beispiele aus den Bereichen Pflanzenproduktion, Tierproduktion und Ökologie fördern eine multidisziplinäre Betrachtungsweise. Sie erlernen in einem Team die verantwortliche Planung von Versuchen unter Berücksichtigung praktischer Restriktionen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Methodisches Arbeiten: Versuchsplanung und -auswertung (Vorlesung, Übung) *Inhalte*: Das Modul soll grundlegende Kenntnisse der Versuchsplanung und -auswertung, die für die Anwendung im Agrarbereich relevant sind, vermitteln. Die Planung und Auswertung z. B. von Feldversuchen, von Fütterungs- und Züchtungsversuchen, von Vergleichen verschiedener Haltungsverfahren, von Umfragen und Erhebungen werden praxisnah dargestellt. Die Vorlesung ist Grundlage für andere Vorlesungen, z.B. im Züchtungsbereich. In einem ersten Teil der Vorlesungen und Übungen werden die Grundlagen zum Schätzen und Vergleichen von typischen Parametern wie Mittelwerten und Varianzen dargestellt. Es werden einfache und faktorielle Versuchsanlagen und deren Auswertung im Rahmen von Varianzanalysen besprochen. Konzepte der Versuchsplanung wie Randomisieren und Art und Umfang der Versuchsanlagen werden besprochen. In Arbeitsgruppen sollen dann typische Versuche aus dem Bereich der Tier- und Pflanzenproduktion und dem Umweltbereich beispielhaft geplant werden. In dem zweiten Teil der Vorlesung werden lineare und nicht-lineare Beziehungen zwischen Variablen einschließlich multivariater Methoden vorgestellt. Die Analyse von Häufigkeitsdaten und die Anwendung von allgemeinen linearen Modellen ergänzen die Vorlesung. In einem weiteren praktischen Teil wird die Auswertung von beispielhaften Versuchen in Arbeitsgruppen geübt. Abgeschlossen wird die Vorlesung mit der Diskussion häufig auftretender Probleme in der Versuchsplanung und -auswertung.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundkenntnisse der • Methoden zur Planung von Versuchen • Statischen Methoden zur Auswertung von Versuchen	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache:	**Modulverantwortliche[r]:**

Deutsch	Prof. Dr. Ahmad-Reza Sharifi
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 80	

Bemerkungen: Dieses Modul und M.Cp.0016 "Practical statistics and experimental design in agriculture" schließen sich gegenseitig aus.

Georg-August-Universität Göttingen **Modul M.Agr.0068: Quantitativ-genetische Methoden der Tierzucht** *English title: Quantitative-genetical Methods in Animal Breeding*	6 C (Anteil SK: 6 C) 6 SWS
Lernziele/Kompetenzen: Alle in der Theorie behandelten Konzepte werden anhand von Beispielen aus der Zuchtpraxis illustriert. In den Übungen werden zum Teil EDV-Programme genutzt. Die Studierenden sind in der Lage, auch komplexere tierzüchterische Problemstellungen auf der Basis solider Methodenkenntnisse zu bearbeiten und die züchterische Relevanz neuer Technologien korrekt einzuschätzen.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
Lehrveranstaltung: Quantitativ-genetische Methoden der Tierzucht (Vorlesung, Übung) *Inhalte*: In dieser Lehrveranstaltung werden die wesentlichen quantitativ-genetischen Konzepte vorgestellt, die der Tierzucht zu Grunde liegen. Ausgehend von den molekulargenetischen Grundlagen und den Regeln der Wahrscheinlichkeitsrechnung werden die wichtigsten genetischen Mechanismen innerhalb von Populationen anhand des Ein-Locus-Modells dargestellt. Behandelt werden Gen- und Genotypfrequenzen unter Gleichgewichtsbedingungen und in dynamischen Systemen, wie etwa unter Selektion. Aus Frequenzen und Genotypwerten werden Varianzen und Kovarianzen sowie die daraus abgeleiteten Populationsparameter wie Heritabilität und genetische Korrelation entwickelt. Auf dieser Basis wird die Selektionstheorie eingeführt und es wird der Selektionsindex zur Kombination von Merkmalen und von Informationsquellen vorgestellt. Das Konzept der Heterosis als Grundlage der Kreuzungszucht wird erläutert und es werden verschiedene Strategien der Kreuzungszucht dargestellt. An ausgewählten Beispielen wird erläutert, wie neue Technologien (z.B. im Reproduktionsbereich) und Informationsquellen (z.B. molekulargenetische Marker) in der Tierzüchtung genutzt werden können.	6 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Wesentliche Kenntnisse in Populationsgenetik in Ein-Locus-Modellen sowie genetischer Parameter, Zuchtwertschätzung, Selektionsindex, in der Ableitung wirtschaftlicher Gewichte und von Kreuzungsparametern.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Ahmad-Reza Sharifi
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

90	

Georg-August-Universität Göttingen **Modul M.Pferd.0001: Bau- und Verfahrenstechnik in der Pferdehaltung** *English title: Horsestable design and process engineering in horse husbandry*	6 C 4 SWS

Lernziele/Kompetenzen: Studierende erlernen Wissen aus unterschiedlichen Basisdisziplinen zu integrieren und mit der Komplexität der Gestaltung der Haltungsumwelt umzugehen. Sie entwickeln Fähigkeiten zur Problemlösung, auch in neuen Fragestellungen, die in einem breiteren Zusammenhang stehen.	**Arbeitsaufwand:** Präsenzzeit: 64 Stunden Selbststudium: 116 Stunden

Lehrveranstaltung: Bau- und Verfahrenstechnik in der Pferdehaltung (Vorlesung, Exkursion, Seminar) *Inhalte*: Im Rahmen dieses Moduls werden zum einen die Grundlagen für eine tiergerechte und umweltverträgliche sowie wirtschaftlich ertragsfähige Pferdehaltung behandelt, zum anderen die baulich-technischen Umsetzungen für die unterschiedlichen Anwendungen (Freizeit, Sport, Zucht usw.) dargestellt. Das Modul umfasst die Grundlagen der Klimagestaltung (Klimaelemente, Klimafaktoren, Thermoregulation bei Pferden, Systeme für Lüftung, Gasbildung sowie Bioaerosole), Grundlagen der Futterversorgung und Fütterungstechnik (Raufutter, Kraftfutter, Weide), Anforderungen an die Einstreu, Einstreuverfahren, Monitoringstechniken, Reststoffverwertung, Bewertungsmodelle für die Tiergerechtheit.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Seminararbeit, Teilnahme Exkursion **Prüfungsanforderungen:** Grundlegende Kenntnisse; Als Stoffgebiet gelten sämtliche Dokumente und Lehrinhalte, die im Rahmen der Vorlesungen vermittelt werden. Zusätzlich sind die Stoffgebiete "Klimagestaltung", "Lüftungssysteme" prüfungsrelevant.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. agr. Sabrina Elsholz
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Pferd.0002: Betriebswirtschaftslehre und Unternehmensführung für Pferdewissenschaftler** *English title: Farm management and administration for equine sciences*	6 C (Anteil SK: 6 C) 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben das methodische Rüstzeug zur Analyse und Planung von (pferdehaltenden) Betrieben. Sie sind in der Lage, das sich im Einzelfall stellende Problem zu identifizieren und die zur Problemlösung geeigneten Techniken zu identifizieren und anzuwenden. Sie werden dadurch in die Lage versetzt, auch komplexe betriebliche Probleme zu durchdringen und zu lösen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Betriebswirtschaftslehre und Unternehmensführung für Pferdewissenschaftler (Vorlesung) *Inhalte*: In diesem Modul wird das Augenmerk auf den Betrieb gerichtet und in die ökonomischen Probleme eingeführt, die bei seiner Bewirtschaftung entstehen können. Gegenstand der Lehrveranstaltung ist die Vermittlung methodischen Grundlagenwissens und dessen Anwendung auf einfache Problemstellungen. Die Lehrinhalte lassen sich wie nachstehend gliedern: • Rechnungswesen und Controlling • Planungsgrundlagen • Produktionsplanung • Investitions- und Finanzplanung • Risikoanalyse und Risikomanagement • Anwendung von erlernten Methoden auf Fallbeispiele	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Es darf keine Prüfung im Modul M.Agr.0060 abgelegt worden sein. **Prüfungsanforderungen:** Umfassende Kenntnisse und fundiertes Wissen zu den in der Vorlesung behandelten Themengebiete.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Oliver Mußhoff
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 45	

Georg-August-Universität Göttingen **Modul M.Pferd.0003: Biologische Grundlagen des Pferdes** *English title: Anatomy and physiology of the horse*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen Anatomie und Physiologie von Organsystemen als Grundlage zum Verständnis der Körperfunktionen und -dysfunktionen	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Biologische Grundlagen des Pferdes (Blockveranstaltung, Vorlesung, Übung) *Inhalte*: • Domestikation des Pferdes • Äußere Anatomie, Körperhöhlen • Herz/Kreislauf • Lunge/Atmung • Magen-Darm • Harn- und Geschlechtsapparat • Bewegungsapparat • Sinnesorgane/Verhalten • Blut/Allgemeine Pathologie	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** regelmäßige Teilnahme an Blockveranstaltung und an den Übungen **Prüfungsanforderungen:** Fundiertes Wissen zu den o. a. Themengebieten (Domestikation des Pferdes, Äußere Anatomie, Körperhöhlen, Herz/Kreislauf, Lunge/Atmung, Magen-Darm, Harn- und Geschlechtsapparat, Bewegungsapparat, Sinnesorgane/Verhalten, Blut/Allgemeine Pathologie)	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** apl. Prof. Dr. Stephan Neumann
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Pferd.0004: Ernährungsphysiologie und Fütterung des Pferdes** *English title: Nutrition Physiology and Feeding of the Horse*	6 C 4 SWS

Lernziele/Kompetenzen: Ausgehend von der Vermittlung ernährungsphysiologischer Zusammenhänge wird die Urteilsfähigkeit gegenüber allen wichtigen Fragen der aktuellen Pferdefütterung vermittelt. Durch Einbeziehung wichtiger Forschungsfragen werden zugleich die Fähigkeit zur gezielten Auseinandersetzung mit hergebrachten Ansichten in der Pferdeernährung und die selbständige Wissensaneignung befördert.	**Arbeitsaufwand:** Präsenzzeit: 62 Stunden Selbststudium: 118 Stunden

Lehrveranstaltung: Ernährungsphysiologie und Fütterung des Pferdes (Vorlesung, Übung) *Inhalte*: Das Modul vermittelt spezielle Kenntnisse über Futterverzehr, Verzehrsverhalten, Verdauungsphysiologie und Stoffwechsel des Pferdes sowie zu den davon abgeleiteten Anforderungen an die Energie-, Nähr- und Wirkstoffversorgung in Abhängigkeit von Alter und Nutzungsform. Ausgehend von futtermittelrechtlichen Regelungen, Futtermittelspektrum und Futterzusatzstoffen in der Pferdeernährung sowie speziellen Anforderungen an die Futtermittelqualität stellen nutzungsangepasste Fütterungskonzepte unter besonderer Beachtung der Prävention von ernährungsbedingten Störungen einen weiteren Schwerpunkt dar. Optimierung der Rationsgestaltung für Pferde Übung zur Futteroptimierung In Zusammenarbeit mit Instituten der Universitäten Leipzig, Halle-Wittenberg, Rostock sowie der Tierärztlichen Hochschule Hannover und Praxisvertretern.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Weiterführende Kenntnisse bezüglich der Besonderheiten von Verzehrsregulation und Futteraufnahme beim Pferd, des Verdauungssystems und der altersabhängigen verdauungsphysiologischen Abläufe sowie der Bewertung der Verdaulichkeit; zudem Besonderheiten des Umsatzes der Hauptnährstoffe für Erhaltungs- und Leistungsprozesse und davon abgeleitete Versorgungsempfehlungen; des Weiteren Futtermittelspektrum und rechtlicher Rahmen für den Einsatz von Futtermitteln und Futterzusatzstoffen; swoie alters- und nutzungsabhängige Fütterungskonzepte; Maßnahmen zur Vermeidung fütterungsbedingter gesundheitlicher Störungen	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jürgen Hummel
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul M.Pferd.0005: Ethologie des Pferdes** *English title: Ethology of the horse*	6 C (Anteil SK: 3 C) 4 SWS
Lernziele/Kompetenzen: Die Studierenden erwerben in diesem Modul Grundlagen der wissenschaftlichen Versuchsmethoden in der Pferde-Ethologie und können ihre Fähigkeiten zur Problemlösung auch in neuen Situationen anwenden. Mit den erworbenen Kenntnissen können sie die Tiergerechtheit von Haltungssystemen für Pferde analysieren und bewerten. Sie erlernen, wissenschaftlich fundierte Entscheidungen zu fällen. Sie verstehen und berücksichtigen die Bedeutung der Mensch-Tier-Beziehung bei Entscheidungen über Haltung, Betreuung und Sport. Sie erwerben forschungsbasierte Kompetenzen in der Vermittlung ethologischer Kenntnisse beim Pferd durch die Analyse von wissenschaftlichen Publikationen. Sie erlernen auf dem aktuellen Stand von Forschung, Schlussfolgerungen zu diskutieren und Fachvertretern wie Laien zu vermitteln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Ethologie des Pferdes (Vorlesung, Seminar) *Inhalte*: • Grundlagen des Verhaltens von Pferden unter besonderer Berücksichtigung endogener und exogener Einflussfaktoren (Reizwahrnehmung, Bewusstsein, Kommunikation, Motivation, Lernen) • Funktionskreise und deren Bedeutung für tiergerechte Haltungssysteme • Auswirkung von Haltungssystemen auf die Verhaltensausprägung, insbesondere die Entwicklung von Verhaltensstörungen • Definition und Erfassung von „Charaktereigenschaften" • Bedeutung der Beziehung zwischen Mensch und Pferd für Haltung, Betreuung und Sport • Ethologische Versuchsmethoden	4 SWS
Prüfung: Präsentation, Referat oder Korreferat (ca. 20 Minuten, Gewichtung 20%) und mündliche Prüfung (ca. 30 Minuten, Gewichtung 80%) **Prüfungsvorleistungen:** Teilnahme am Seminar **Prüfungsanforderungen:** Grundlagen des Verhaltens, Funktionskreise und tiergerechte Haltungssysteme, ethologische Versuchsmethoden, Interpretation von wissenschaftlichen Untersuchungen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. sc. agr. Vivian Gabor
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester

Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Bemerkungen: 3 Credits werden als Schlüsselkompetenz angerechnet

Georg-August-Universität Göttingen **Modul M.Pferd.0006: Hygiene, Erkrankungen und Haltung des Pferdes** *English title: Hygiene, diseases and husbandry systems of horses*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden besitzen Kenntnisse über Haltungs- und Produktionverfahren der Pferdehaltung sowie über haltungsbedingte Erkrankungen in den verschiedenen Systemen. Sie können mit diesem theoretischen Hintergrund Praxisbetriebe beurteilen, bewerten und Betriebsleiter kompetent beraten. Des Weiteren sind sie in der Lage Betriebe neu zu entwickeln und interdisziplinär Problembereiche zu lösen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Hygiene, Erkrankungen und Haltung des Pferdes (Vorlesung, Übung) *Inhalte*: • Bewertungsverfahren von Produktionsformen und -abläufen der Pferdehaltung • Bewertung von Managementmaßnahmen • Kenntnisse um Erkrankungen in den Bereichen Innere Medizin, Chirurgie und Orthopädie • Kenntnisse zu haltungs- und nutzungsbedingten Erkrankungen • Prophylaxemaßnahmen zur Vermeidung von Krankheiten • Kenntnisse zum Betrieb einer tierärztlichen Klinik für Pferde aus medizinischer und hygienischer Sicht	4 SWS
Prüfung: Klausur (60 Minuten, 50%) und Referat (ca. 90 Minuten, 50%) **Prüfungsanforderungen:** Spezifische Kenntnis und dezidierte Fähigkeit zur Bewertung von Haltungsverfahren für Pferde sowie von Produktionsformen und -abläufen in der Pferdehaltung; weitreichende Kenntnisse um Erkrankungen in den Bereichen Innere Medizin, Chirurgie und Orthopädie sowie zu haltungs- und nutzungsbedingten Erkrankungen; umfassende Kenntnisse zum Betrieb einer tierärztlichen Klinik für Pferde aus medizinischer und hygienischer Sicht sowie von Managementmaßnahmen zur Gesunderhaltung der Bestände.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. agr. Sabrina Elsholz
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Pferd.0007: Infektions- und Seuchenhygiene in der Pferdehaltung** *English title: Infectious disease and hygiene in the horse husbandry*	6 C 4 SWS
Lernziele/Kompetenzen: Durch die allgemeinen und spezifischen Kenntnisse auf dem Gebiet der Infektiologie und Seuchenhygiene bei Equiden beherrschen die Studierenden auf dem aktuellen Stand von Forschung und Praxis moderne Hygiene- und Haltungskonzepte zu beurteilen und selbständig zu entwickeln. Sie können zielorientiert komplexe Hygiene- und Qualitätssicherungsprogramme etablieren. Sie können die erlernten Fähigkeiten im späteren multidisziplinären Berufsfeld sicher anwenden und vermitteln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Infektions- und Seuchenhygiene in der Pferdehaltung (Praktikum, Vorlesung) *Inhalte*: Infektionskrankheiten und Allergien spielen in der Pferdehaltung seit jeher eine bedeutende Rolle. Dies wird sich im Zuge einer wachsenden Globalisierung in der Pferdezucht, im Pferdesport und in Hobbyhaltungen weiter verstärken. Nach der deutschen Viehverkehrsordnung ist seit dem Jahr 2000 für alle Equiden u.a. aus Gründen der Seuchenhygiene ein Pass obligatorisch. Das Modul soll einen spezialisierten Einblick in das Infektions- und Seuchengeschehen bei Einhufern geben und Verständnis für die Bekämpfungsmöglichkeiten erwecken. Dabei steht der aktuelle Bezug zur späteren vielfältigen Berufspraxis der Studierenden im Vordergrund. Neben einer Einführung in die Qualität und Funktion der körpereigenen Immunabwehrsysteme der Einhufer, werden ausgewählte und aktuell relevante Infektionskrankheiten vorgestellt, einschließlich der Möglichkeiten zur Diagnose, Prophylaxe und Therapie. Hierbei stehen virale Infektionen (z.B. equine Herpesviren EHV1 und EHV4, Influenza, Infektiöse Anämie, Borna'sche Krankheit, Equine Artritis etc.) ebenso im Fokus wie bakterielle Ursachen (ansteckende Gebärmutterentzündung bzw. CEM, Borreliose, Botulismus, Fohlenlähme, Tetanus, Druse) oder Infektionen durch Pilze (z.B. Luftsack- oder Hautmykosen), Protozoen (Beschälseuche durch Trypanosoma equiperdum) und Parasiten. Neben seit langem heimischen Infektionskrankheiten werden auch bereits ausgerottete und reimportierte Pferdeseuchen (z.B. Rotz) behandelt oder in unseren Breiten neu auftretende Seuchen (z.B. Enzephalopathien). Einige der vorgestellten Erreger sind Auslöser gefährlicher Epidemien (Influenza, Tetanus) oder stellen als Zoonoseerreger eine besondere und tödliche Gefahr für den Menschen dar (Tollwut, Rotz). Die Einflüsse der vermehrten Gruppenhaltung von Pferden in Ställen und Herden (Pensions-, Handelsställe, Gestüte etc.) oder die epidemiologische Bedeutung der zunehmenden nationalen und internationalen geographischen Mobilität (nationale und internationale Turniere, Auktionen, Pferdesportveranstaltungen, Zucht, Import, Export) auf die Verbreitung von Erregern werden eingehend behandelt. In diesem Zusammenhang wird auch der immunsuppressive Einfluss von Stress erläutert und die daraus resultierende Gefährdung ganzer Pferdepopulationen durch infizierte, klinisch unauffällige Ausscheider von Infektionserregern. Die Studierenden lernen geeignete Maßnahmen zur Verhinderung seuchenhafter Ausbrüche von Infektionskrankheiten	4 SWS

und zum Schutz des einzelnen Pferdes sowie des gesamten Bestandes kennen. Das gilt für die Prinzipien und Entwicklungen von aktiven und passiven Schutzimpfungen, einschließlich eines optimierten Kolostralmilchmanagements, wie auch für neue Möglichkeiten der Immunmodulation, der Behandlung von Allergien und der Optimierung von Haltungsparametern im Sinne einer hygienischen Prophylaxe (Quarantänestallungen z.B. in Gestüten) zusammen mit Koppel- bzw. Weide- und Parasitenmanagement. Bei allen Themengebieten werden die gesetzlichen Grundlagen der Tierseuchenbekämpfung und des Tierschutzes berücksichtigt.	
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Vertiefte Kenntnisse der Biologie und Pathogenese von Tierseuchenerregern bei Einhufern, Infektiologie und Immunnologie bei Equiden, Schutzimpfungen, Allergien, allgemeinen Haltungshygiene, speziellen Hygieneprogramme in Pferdezucht und -sport, Transport- und Umwelthygiene, Tierseuchengesetz und staatlichen Tierseuchenbekämpfung bei Equiden.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jens Tetens
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Pferd.0008: Leistungs- und Trainingsphysiologie des Pferdes** *English title: Performance and exercise physiology of the horse*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden erlernen Funktionsabläufe in komplexen biologischen Systemen sowie deren Beeinflussbarkeit durch aktuelle Trainingsprogramme. Sie werden ferner darin ausgebildet, Merkmale, Möglichkeiten sowie Grenzen von Training im Leistungssport gegenüber Fachvertretern und Laien kompetent darzustellen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Leistungs- und Trainingsphysiologie des Pferdes (Vorlesung, Seminar) *Inhalte*: Einleitung: • Historisches • Grundziele im Pferdesport • Pferd als Leistungssportler • Leistungsbegriff • Tierschutz im Leistungssport Ausbildung und Training: • Leistungsgrundlagen • Bewegungsapparat • Herz-Kreislauf • Respiration • Temperatur (Thermoregulation) • Energiestoffwechsel • Endokrinologie (hormonelle Steuerung von Leistung, Regelsysteme) • Adaptation (Anpassung biologischer Systeme an Leistung) Training: • Trainingsprinzipien • Trainingsziel • Trainingsinhalte • Trainingsprogramme • Trainingsmethoden • Trainingsmittel • Trainingsübungen • Trainingskontrolle • Trainingsstudien/Trainingsmodelle (Eigene und andere Studien) • Doping	4 SWS
Prüfung: Präsentation, Referat oder Korreferat (ca. 20 Minuten, Gewichtung 20%) und mündliche Prüfung (ca. 20 Minuten, Gewichtung 80%) **Prüfungsvorleistungen:** Teilnahme am Seminar	6 C

Prüfungsanforderungen: Einführende Kenntnisse bezüglich der leistungsrelevanten physiologischen Systeme und Trainingsprogramme sowie den Grenzen der Leistung	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** M.Pferd.0025 Physiologie von Organsystemen
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Gerhard Breves
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

<table>
<tr><td>Georg-August-Universität Göttingen
Modul M.Pferd.0011: Organisation, Reitweisen und Ausbildungssysteme im deutschen Pferdesport
English title: Organization, methods and training systems of riding in germany</td><td>6 C</td></tr>
<tr><td>Lernziele/Kompetenzen:
Die Studierenden besitzen umfassende Kenntnisse über die Verbandsstrukturen des Pferdesports und der Pferdezucht in Deutschland. Sie sind in der Lage, diese für unterschiedliche Anforderungen und Fragestellungen zu nutzen. Sie können sowohl die Gemeinsamkeiten als auch die Unterschiede verschiedenerer Reitweisen und Trainingsmethoden einschätzen. Dieser Überblick gibt ihnen eine Sensibilität für problematische Fragestellungen in diesem Zusammenhang. Die ganzheitliche Betrachtungsweise ist durch die Kenntnisse tierschutzrelevanter Fragestellungen abgerundet. Die Kenntnisse umweltpolitischer Besonderheiten und regionaler Unterschiede auf den verschiedenen Ebenen ermöglichen eine Einordnung von Entscheidungswegen und ggf. ein notwendig werdendes Engagement.</td><td>Arbeitsaufwand:
Präsenzzeit:
62 Stunden
Selbststudium:
118 Stunden</td></tr>
<tr><td>Lehrveranstaltung: Organisation, Reitweisen und Ausbildungssysteme im deutschen Pferdesport (Blockveranstaltung, Vorlesung, Übung)
Inhalte:
Die Lehre der unterschiedlichen Reitweisen sowie der Ausbildungssysteme im deutschen Reit- und Fahrsport stehen im Mittelpunkt dieser Vorlesungen. Dabei werden Grundsätze sowie Zusammenhänge der Reitlehre und der Ausbildungssysteme in Vorlesungen erläutert sowie an praktischen Demonstrationen im Rahmen eines Aufenthaltes in Warendorf verdeutlicht. Einen weiteren Schwerpunkt des Wahlmoduls wird die Organisation des Pferdesports und der Pferdezucht in Deutschland bilden. Die Themen dieser Vorlesungen umfassen sowohl die historischen sowie die aktuellen Strukturen in Deutschland als auch die Organisation von Veranstaltungen, tierschutzrelevante Aspekte im Turniersport sowie breitensportliche Gesichtspunkte. Durch die Vorstellung der gültigen Regelwerke und gesetzlichen Grundlagen werden die rechtlichen Rahmenbedingungen des Gesamtverbandes aufzeigt.
Literatur: Vorlesungsskripte sowie weitere Literaturhinweise in der Lehrveranstaltung</td><td></td></tr>
<tr><td>Prüfung: Klausur (90 Minuten)
Prüfungsanforderungen:
Umfassende Kenntnisse und fundiertes Wissen zu den o. a. Themengebieten (Grundsätze sowie Zusammenhänge der Reitlehre und der Ausbildungssysteme, Organisation des Pferdesports und der Pferdezucht in Deutschland; Organisation von Veranstaltungen, tierschutzrelevante Aspekte im Turniersport sowie breitensportliche Gesichtspunkte, etc.)</td><td>6 C</td></tr>
</table>

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jens Tetens Dr. Enrica Zumnorde-Mertens

Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Pferd.0012: Pferdezucht und -genetik** *English title: Horse breeding and genetics*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen ihr Wissen und ihre Fähigkeiten zur Problemlösung auch in neuen und unvertrauten Situationen anzuwenden. Sie können ihr erlerntes Wissen integrieren und lernen mit komlexen Fragestellungen umzugehen. Sie sind in der Lage auch auf Grundlage unvollständiger oder begrenzter Informationen wissenschaftlich fundierte Entscheidungen zu fällen. Die Studierenden können auf dem aktuellen Stand von Forschung und Anwendung Fachvertretern und Laien ein Thema wissenschaftlich begründen und ihre Schlussfolgerungen klar vermitteln.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Pferdezucht und -genetik (Vorlesung, Übung) *Inhalte*: • Genetische Aspekte der Domestikation, Rassen und deren Ursprung, Struktur von Pferdezuchtpopulationen; • Genetik von morphologischen, physiologischen, Leistungs- und Gesundheitsmerkmalen; Stand der Farbvererbung und Verhaltensgenetik; • Methoden der züchterischen Verbesserung und Zuchtwertschätzung; • Formen der Leistungsprüfung, Zuchtwertschätzung und Zuchtplanung; • Analyse von aktuellen Zuchtprogrammen für ausgewählte Populationen	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse der genetischen Aspekte und vertiefte Kenntnisse der Methoden, Formen und Analyse der Zucht (siehe Lehrinhalte)	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jens Tetens
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen Modul M.Pferd.0015: Spezielles Praxismodul - Trainer *English title: Practical course - Horse Trainer*	6 C 1 SWS
Lernziele/Kompetenzen: • Pferdetraining • Ausbildung • Durchführung von Prüfungen	**Arbeitsaufwand:** Präsenzzeit: 14 Stunden Selbststudium: 166 Stunden
Lehrveranstaltung: Spezielles Praxismodul - Trainer (Vorlesung) *Inhalte*: Je nach Ausbildungsschwerpunkt können folgende Abschlüsse als Praxismodul gewertet und nach zusätzlichen Vorlesungen und einer zusätzlichen Prüfung durch den Modulkoordinator anerkannt werden. • Trainer C Trainer C – Reiten – Basissport oder Leistungssport; Distanzreiten – Leistungssport; Westernreiten – Leistungssport; Fahren – Leistungssport; Voltigieren - Basissport oder Leistungssport oder • Trainer B Trainer B – Reiten – Basissport oder Leistungssport; Distanzreiten – Leistungssport; Westernreiten – Leistungssport; Fahren – Leistungssport; Voltigieren - Basissport oder Leistungssport oder • Trainer A Trainer A – Reiten –Leistungssport; Westernreiten – Leistungssport; Fahren-Leistungssport; Voltigieren - Leistungssport	1 SWS
Prüfung: Hausarbeit (max. 10 Seiten) **Prüfungsvorleistungen:** Abgeschlossene Ausbildung (gem. der Ausbildungs- und Prüfungsordnung der Deutschen Reiterlichen Vereinigung **Prüfungsanforderungen:** Vielschichtige Kenntnisse müssen nachgewiesen werden aus den Bereichen Trainer C, B. oder A (Reiten).	6 C

Zugangsvoraussetzungen: Gemäß der Ausbildungsordnung der Deutschen Reiterlichen Vereinigung	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. rer. agr. Sabrina Elsholz
Angebotshäufigkeit:	**Dauer:**

jedes Semester	1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 5	

Georg-August-Universität Göttingen **Modul M.Pferd.0018: Weidemanagement** *English title: Grazing management*	6 C (Anteil SK: 3 C) 4 SWS
Lernziele/Kompetenzen: Studierende lernen die theoretischen Grundlagen der Grünlandwirtschaft und Weidewirtschaft auf Pferde haltenden Betrieben kennen, wobei methodische und analytische Kompetenzen im Vordergrund stehen. Sie können verschieden strukturierte Daten (Flächen-, Betriebsdaten, verschiedene Kategorien von Variablen) komplex auswerten and analysieren. Sie vertiefen ihre Kenntnisse und Fertigkeiten im Hinblick auf die Vorstellung und Kommunikation der eigenen Projektarbeit. Sie lernen ihre Standpunkte argumentativ zu untermauern und sich mit anderen über Problemlösungsstrategien auszutauschen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Weidemanagement (Vorlesung, Übung, Seminar) *Inhalte*: Anlage von Pferdeweiden, Standorteignung, Böden, Vegetation von Pferdeweiden, Verbesserung und Pflege von Pferdeweiden, Bodenverdichtung, Staunässe, Verunkrautung, Ansprüche der Pferde bei Weidegang, spezifisches Weideverhalten, Ernährung, Bewegung, Leistungsanforderungen an Pferde, Futterproduktion auf der Weide, Winterfutterbereitung für Pferde, Futterkonservierung, Düngung und Nährstoffmanagement, Umweltaspekte, Weidesysteme, Koppel-, Standweide Landschaftspflege mit Pferden. Kennenlernen der wichtigsten Pflanzenarten des Graslands, Techniken der Identifikation von Pflanzenarten bzw. der Aufnahme von Pflanzenbeständen. Durchführung einer Projektarbeit, in der Studierende in Kleingruppen (zwei bis drei Studierende) eigenständig eine Analyse der Weidewirtschaft eines selbst gewählten pferdehaltenden landwirtschaftlichen Betriebs durchführen. Das umfasst die detaillierte Aufnahme der Produktionsbedingungen auf dem Betrieb, die Vegetationsaufnahme der Grünlandschläge sowie Aufnahme der Standort- und Bewirtschaftungsbedingungen des Grünlands. Methoden der Datenaufnahme und komplexen Analyse werden vorgestellt und sollen im Projekt angewendet werden. Vortrag der Ergebnisse im Rahmen des Seminars.	4 SWS
Prüfung: Mündliche Prüfung (ca. 20 min, Gewichtung 60%) und Referat (ca. 15 Minuten, Gewichtung 40%) **Prüfungsvorleistungen:** Durchführung einer Projektarbeit und Vorstellung der Ergebnisse im Rahmen der Veranstaltung **Prüfungsanforderungen:** Tiefere Kenntnis der theoretischen Grundlagen der Grünlandwirtschaft und Weidewirtschaft auf Pferde haltenden Betrieben. Die Studierenden beherrschen die Fähigkeit verschieden strukturierte Daten (Flächen-, Betriebsdaten, verschiedene Kategorien von Variablen) komplex auszuwerten und zu analysieren. Vertiefende Kenntnisse und Fertigkeiten im Hinblick auf die Vorstellung und Kommunikation der eigenen Projektarbeit sind vorhanden.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Johannes Isselstein
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

Georg-August-Universität Göttingen **Modul M.Pferd.0020: Sportmarketing** *English title: Sports Marketing*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden lernen zentrale Anwendungsfelder des Sportmarketings und die entsprechenden Planungsmethoden kennen. Sie sind damit auf die Anforderungen der Berufsfelder in der Sportindustrie und im Sportdienstleistungssektor vorbereitet. Exemplarisch vertieft das Modul den Bereich des Pferdesportes, ergänzend werden aber auch Kenntnisse anderer Sektoren der Sportbranche vermittelt. Die Veranstaltung bereitet insgesamt auf eine wissenschaftliche Beschäftigung mit dem Sportmarketing und auf eine Tätigkeit in der Sportindustrie bzw. Sportinstitutionen vor.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Sportmarketing (Tutorium, Seminar) *Inhalte*: Die Veranstaltung stellt anwendungsorientiert die zentralen Felder des Sportmarketings vor. Sportveranstalter und -dienstleister stehen vor der Herausforderung zunehmend professioneller Managementstrukturen. Angesichts des heterogenen Kenntnisstandes der Studierenden im Studiengang MSc Pferdewissenschaften erfolgt die Einarbeitung in die Themengebiete des Marketings anhand von Fallstudien und Projekten, wobei besonderer Wert auf die Spezifika des Sport- und speziell des Pferdesportmarktes gelegt wird. Dabei erfolgt auch eine Einführung in die statistische Auswertungssoftware SPSS.	
Prüfung: Klausur (60 Minuten, Gewichtung: 50%) und Präsentation (ca. 20 Minuten) mit schriftlicher Ausarbeitung (max. 15 Seiten) (Gewichtung: 50%) **Prüfungsvorleistungen:** Teilnahme am Tutorium **Prüfungsanforderungen:** Das Modul besteht aus einem theoretischen Teil und einem anwendungsorientierten Projekt, in dem die Studierenden eine aktuelle Themenstellung selbständig (in Gruppen) bearbeiten und präsentieren. Dabei sollen die im theoretischen Teil behandelten Gebiete (Besonderheiten des Sportmarketings, Sportlerverhalten, Medienentwicklung, Marketing-Planungsprozesse, Eventmanagement, Kontrolle, Marktforschung und empirische Auswertungsmethoden) genutzt werden.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Marketinggrundkenntnisse wünschenswert
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Achim Spiller
Angebotshäufigkeit: jedes 4. Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

50	

Georg-August-Universität Göttingen **Modul M.Pferd.0021: Pferdewissenschaftliches Seminar (Journal Club)** *English title: Journal Club in Equine Sciences*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erwerben Kompetenzen in der Erschließung und Diskussion wissenschaftlicher Themen unter Verwendung aktueller pferdewissenschaftlicher Literatur. Außerdem erwerben sie Fähigkeiten im Bereich der schriftlichen und mündlichen Präsentation wissenschaftlicher Themen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Pferdewissenschaftliches Seminar (Journal Club) (Vorlesung, Seminar) *Inhalte*: Methoden der Recherche und Sammlung wissenschaftlicher Inhalte zu einem bestimmten Thema. Fundierte Diskussion wissenschaftlicher Inhalte auf der Basis umfangreicher Literaturrecherche. Aufbereitung und Präsentation wissenschaftlicher Fakten.	4 SWS
Prüfung: Präsentation (ca. 15 Minuten) mit schriftlicher Ausarbeitung (max. 10 Seiten) **Prüfungsvorleistungen:** Aktive Teilnahme an 50% der Seminartermine **Prüfungsanforderungen:** Vorbereitung einer literaturbasierten Seminarpräsentation inklusive Diskussion und schriftlicher Ausarbeitung, Vorbereitung einer Komoderation mit Diskussionsleitung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jens Tetens
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Pferd.0022: Reproduktion des Pferdes** *English title: Equine Reproduction*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden sind mit den anatomischen Besonderheiten bei der Fortpflanzung des Pferdes vertraut und kennen die verschiedenen Arbeitstechniken fortpflanzungsbiologischer und biotechnischer Verfahren. Sie kennen die aktuellen Praxis- und Forschungsschwerpunkte und sind in der Lage mit relevanten Fachbegriffen zu argumentieren.	**Arbeitsaufwand:** Präsenzzeit: 62 Stunden Selbststudium: 118 Stunden

Lehrveranstaltung: Reproduktion des Pferdes (Vorlesung, Exkursion) *Inhalte*: Anatomische und physiologische Besonderheiten der Fortpflanzung des Pferdes; • Kenntnis und Anwendung fortpflanzungsbiologischer und biotechnischer Verfahren und Methoden; • Reproduktionsmanagement in Zuchtbetrieben; Ethik, rechtliche Wertung und gesellschaftliche Akzeptanz fortpflanzungsbiologischer Verfahren und Methoden • Exkursion zu einem pferdehaltenden Betrieb	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Teilnahme an der Exkursion **Prüfungsanforderungen:** Einführende Kenntnisse in den Bereichen: Biotechniken, Endokrinologie, Ethik, Tierernährung, Tierhygiene, Tierhaltung, Physiologie, Genetik	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Michael Hölker
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Pferd.0023: Projektarbeit: Wissenschaft in der Pferdewirtschaft** *English title: Project work: Science in the equine sector*	6 C 6 SWS
Lernziele/Kompetenzen: Fachbezogene Kenntnisse des jeweiligen Arbeitsgebietes, soziale Kompetenzen (Arbeitsorganisation, Teamarbeit, Interdisziplinäres Arbeiten, Flexibilität), praktisch methodische Kompetenzen, Übertragung wissenschaftlicher Erkenntnisse in die Praxis der Pferdebranche	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Projektarbeit: Wissenschaft in der Pferdewirtschaft *Inhalte*: Projektarbeit (mind. 4 Wochen) in unterschiedlichen Einrichtungen des vor- und nachgelagerten Bereichs, z.B. Forschungseinrichtungen, Industrie, Verwaltung, Verbände, Beratung, Politik. Einblick in Arbeitsmethoden, Aufgaben, Berufsalltag. Erwerb praktisch-anwendungsbezogener Kenntnisse. Die Anfertigung der Projektarbeit auf landwirtschaftlichen Betrieben ist nicht möglich.	4 SWS
Prüfung: Projektarbeit (max. 20 Seiten) **Prüfungsanforderungen:** Nachweis von fachbezogenen Kenntnissen des Arbeitsgebietes, fundierte Kenntnisse von Arbeitsorganisation, Teamarbeit, Interdisziplinäres Arbeiten, Flexibilität, praktisch methodische Kompetenzen. Projektarbeit zur Anwendbarkeit wissenschaftlicher Erkenntnisse in der Pferdebranche anhand eines Beispiels aus dem Bereich des individuellen Praktikums.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jens Tetens
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen **Modul M.Pferd.0024: Recht** *English title: Economics and Law*	6 C (Anteil SK: 3 C) 4 SWS

Lernziele/Kompetenzen: Teilmodul 1 Recht: Die Studierenden besitzen Grundkenntnisse über alle relevanten Rechtsfragen im Bereich Pferdezucht und -haltung. Sie können rechtliche Fragen in diesem Bereich grundlegend einschätzen, Ergebnisse juristischer Auseinandersetzungen bewerten und erste, beratende Empfehlungen abgeben Teilmodul 2 Weiterführende, rechtliche Grundlagen der Pferdehaltung und –nutzung: Die Studierenden besitzen ein tieferes Verständnis für die relevanten Rechtsfragen im Bereich der Pferdezucht und –haltung sowie Grundkenntnisse über Inhalte des öffentlichen Rechts in Bezug auf das Pferd sowie allgemeine Haftungsfragen nach dem BGB im Rahmen von Pferdesportveranstaltungen. Sie können rechtliche Fragen in diesen Bereichen grundlegend einschätzen, Ergebnisse juristischer Auseinandersetzungen bewerten und erste beratende Empfehlungen abgeben.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Recht I (Vorlesung, Übung) *Inhalte*: • der zivilrechtliche Vertrag • das Tierkaufrecht insbesondere das Pferdekaufrecht • Mängelrechte beim Tierkauf • das Pferdepensionsrecht • Haftungsfragen im reiterlichen Umfeld • das Tierzuchtrecht *Angebotshäufigkeit:* jedes Wintersemester	2 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse und Gestaltung zivilrechtlicher Verträge. Inhalte des Tierkaufrechtes, insbesondere des Pferdekaufrechtes. Kenntnisse über Mängelrechte beim Tierkauf, das Pferdepensionrecht, das Tierzuchtgesetz sowie von Haftungsfragen im reiterlichen Umfeld.	3 C

Lehrveranstaltung: Weiterführende, rechtliche Grundlagen der Pferdehaltung und –nutzung (Vorlesung, Übung) *Inhalte*: Die Inhalte des vorhergehenden Teilmoduls „Recht“ zum Tierkaufrecht, Mängelrechte beim Tierkauf, Pferdepensionsrecht, Haftungsfragen im reiterlichen Umfeld und zum Tierzuchtrecht werden vertieft und ausgeweitet. Hinzu kommen Inhalte des öffentlichen Rechts wie Tierseuchenrecht, Pferdepässe und Tierschutzrecht in Bezug auf das Pferd sowie allgemeine Haftungsfragen nach dem BGB aus Sicht der Pferdesportveranstalter und sonstiger Beteiligter (z.B. Richter und Parcoursbauer). *Angebotshäufigkeit:* jedes Sommersemester	2 SWS

Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundkenntnisse über Inhalte des öffentlichen Rechts in Bezug auf das Pferd sowie allgemeine Haftungsfragen nach dem BGB im Rahmen von Pferdesportveranstaltungen. Einschätzung und Bewertung rechtlicher Fragen in den aufgeführten Rechtsgebieten rund ums Pferd.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jens Tetens
Angebotshäufigkeit: siehe Lehrveranstaltung	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Modul M.Pferd.0025: Physiologie von Organsystemen** *English title: Physiology of organ systems*	6 C 4 SWS
Lernziele/Kompetenzen: Die Studierenden kennen die Funktionsprinzipien der Organsysteme, die mit der Leistungsphysiologie eng assoziiert sind (Herz/Kreislauf, Atmung, Thermoregulation, Muskulatur). Sie sind in der Lage, die entsprechendenphysiologischen Funktionsweisen zu erläutern.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Physiologie von Organsystemen (Vorlesung, Seminar) *Inhalte*: Herzaktion, Herzautonomie, Vegetative Regulation von Kreislauffunktionen, Mikrozirkulation, Atemzeitvolumen, Messmethoden, Atmungsregulation, Mechanismen der Wärmebildung und -abgabe, Mechanismen der trockenen und feuchten Wärmeabgabe, Messungen von Temperaturfeldern mittels Wärmebildkamera, Vergleichende Muskelstruktur, neuromuskuläre Erregungsübertragung, Mechanismen und Steuerung der Hypertrophie	4 SWS
Prüfung: Präsentation, Referat oder Korreferat (ca. 20 Minuten, Gewichtung 30%) und mündliche Prüfung (ca. 20 Minuten, 70%) **Prüfungsvorleistungen:** Teilnahme am Seminar **Prüfungsanforderungen:** Kenntnisse in den Bereichen Herz/Kreislauf, Atmung, Thermoregulation, Muskulatur	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Gerhard Breves
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	