Datum: 31.01.2020 Nr.: 2

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Amtliche Mitteilungen II

Fakultät für Mathematik und Informatik:

Nach Beschluss des Fakultätsrats der Fakultät für Mathematik und Informatik vom 08.01.2020 hat das Präsidium der Georg-August-Universität Göttingen am 21.01.2020 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 01.04.2020 in Kraft.

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. 5/2020 S. 92)

Module

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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 W "Economathematics"

In the research-oriented study track W "Economathematics" modules below have to be completed successfully according to the regulations.

Im forschungsorientierten Studienprofil W "Wirtschaftsmathematik" sind Module nach Maßgabe der nachstehenden Bestimmungen erfolgreich zu absolvieren.

a. Elective compulsory modules in the subject-specific area (60 C)

In the study track W, 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 W müssen Wahlpflichtmodule im Fach Mathematik im Umfang von insgesamt mindestens 60 C nach Maßgabe der folgenden Bestimmungen erfolgreich absolviert werden:

aa. Elective compulsory modules in SP 3

In the study focus SP 3, modules with a total of at least 18 C have to be completed successfully, thereof the following module:

Es müssen Module aus SP 3 im Umfang von insgesamt wenigstens 18 C erfolgreich absolviert werden, darunter das folgende Modul:

bb. Elective compulsory modules in SP 4

In the study focus SP 4, modules with a total of at least 18 C have to be completed successfully, thereof the following module:

Es müssen Module aus SP 4 im Umfang von insgesamt wenigstens 18 C erfolgreich absolviert werden, darunter das folgende Modul:

cc. (Advanced) seminar in the study focus

In the study focus of the Master's thesis, a seminar module or an advanced seminar module with 3 C (M.Mat.483*, M.Mat.484*, M.Mat.493*, M.Mat.494*) has to be completed successfully. Only the study foci SP 3 or SP 4 are permitted as study focus of the Master's thesis.

Im Studienschwerpunkt der Masterarbeit muss ein Seminar- oder Oberseminarmodul im Umfang von 3 C erfolgreich absolviert werden. Als Schwerpunkt der Masterarbeit sind nur die Schwerpunkte SP 3 oder SP 4 zugelassen.

dd. 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:

ee. Computer science

In the area No. III)4) "Computer science", one module with 5 C has to be completed successfully, the following two modules are recommended.

Es muss ein Modul aus dem Bereich "III)4) Informatik" im Umfang von 5 C erfolgreich absolviert werden. Empfohlen werden.

ff. Elective modules

Furthermore, in the study foci or in one of the minor subjects Business Administration, Economics or Business Law, modules with a total of at least 6 C have to be completed successfully.

Ferner müssen Module im Gesamtumfang von wenigstens 6 C aus einem der Schwerpunkte oder aus den Nebenfächern Betriebswirtschaftslehre, Volkswirtschaftslehre oder Wirtschaftsrecht erfolgreich absolviert werden.

b. Elective compulsory modules in the minor subject (14 C)

In the study track W, out of the following minor subjects modules with a total of at least 14 C have to be completed successfully: Business Administration, Economics or Business law. 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 W sind Module im Gesamtumfang von mindestens 14 C aus den folgenden Nebenfächern erfolgreich zu absolvieren: Betriebswirtschaftslehre, Volkswirtschaftslehre oder Wirtschaftsrecht. Die wählbaren Module sind in "III. Minor subjects in the graduate programme in Mathematics" geregelt.

c. Elective modules in the key competencies area (16 C)

Modules with a total of at least 16 C have to be completed successfully according to the following regulations:

Es sind Module im Gesamtumfang von wenigstens 16 C nach Maßgabe der folgenden Bestimmungen erfolgreich zu absolvieren.

aa. Internship

In the study track W, the following module with 10 C has to be completed successfully:

Im Studienprofil W ist das folgende Modul im Umfang von 10 C erfolgreich zu absolvieren:

bb. Further key competencies modules

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. It is recommended to choose one of the following modules:

Ferner kann 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. Es wird empfohlen, eines der folgenden Module zu absolvieren:

3. 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 2 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.

4. 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.

Im forschungsorientierten Studienprofil MDS "Mathematical Data Science" sind Module nach

Maßgabe der nachstehenden Bestimmungen erfolgreich zu absolvieren.

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.

- 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. (Advanced) seminar in the study focus

In the study focus of the Master's thesis, a seminar module or an advanced seminar module with 3 C (M.Mat.483*, M.Mat.484*, M.Mat.493*, M.Mat.494*) has to be completed successfully. Only the study foci SP 3 or SP 4 are permitted as study focus of the Master's thesis.

Im Studienschwerpunkt der Masterarbeit muss ein Seminar- oder Oberseminarmodul im Umfang von 3 C erfolgreich absolviert werden. Als Schwerpunkt der Masterarbeit sind nur die Schwerpunkte SP 3 oder SP 4 zugelassen.

dd. 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:

ee. 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.

ff. 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.ee) "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.ee) "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.ee) "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.ee) "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 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. It is recommended to choose one of the following modules.

Es ist ein Schlüsselkompetenzmodul aus dem Angebot der Fakultät für Mathematik und Informatik 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 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"

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

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

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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

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.

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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: Informatik I
- B.Inf.1102: Informatik II
- B.Inf.1801: Programmierkurs

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.

Im Nebenfach "Philosophie" stehen folgende Module zur Auswahl; in einem der gewählten Module muss eine Hausarbeit angefertigt werden:

6. Physics

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

8. Business Law (Nebenfach)

In the study track Economathematics, in "Business Law" as a minor subject the module below as well as modules out of the core curriculum of the Bachelor's programme with two subjects, subject "Law", can be chosen, provided the required previous knowledge in each case is given and with the exception of the modules of the basic courses in Civil Law (module numbers S.RW.011*). It is especially recommended to choose modules in one of the module packets in the practice-oriented track of the 2FBA undergraduate programme as well as to participate in a study advisory service.

Im Studienprofil W können im Nebenfach "Wirtschaftsrecht" mit Ausnahme der Grundkurs-Module im Bürgerlichen Recht (Modulnummern S.RW.011*) das nachstehende Modul sowie alle Module aus dem Kerncurriculum des Teilstudiengangs „Rechtswissenschaften" des Zwei-Fächer-Bachelor-Studiengangs (2FBA) bei Vorliegen der jeweils erforderlichen Vorkenntnisse belegt werden. Empfohlen wird, insbesondere Module zu wählen, die einem der rechtswissenschaftlichen Modulpakete im berufsfeldbezogenen Profil des 2FBA zugeordnet sind, sowie die Teilnahme an einer Studienberatung.

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.

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V. Master's thesis

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

VI. Additional optional modules ("Zusatzmodule") (graduate studies)

In addition to the compulsory, the elective compulsory and the elective modules, additional optional modules can be completed, a distinction is made between two classes.

Es können weitere als die erforderlichen Module als Zusatzmodule absolviert werden. Es wird zwischen den nachstehenden Gruppen unterschieden.

1. Additional optional modules ("Zusatzmodule") in Mathematics (graduate studies)

Upon written request the grades of additional optional modules ("Zusatzmodule") are counted towards the overall grade of the Master's Degree. This option is restricted to modules with numbers B.Mat.**** and M.Mat.**** and it is limited to a total of 30 C. These modules are listed as additional optional courses on the Master's Degree certificate and the Transcript of Records.

Auf Antrag werden Noten von freiwilligen Zusatzleistungen ("Zusatzmodule") in Modulen B.Mat.**** oder M.Mat.***** des Master-Studiengangs Mathematik im Umfang von höchstens 30 C bei der Berechnung des Gesamtergebnisses der Masterprüfung berücksichtigt. Diese Zusatzmodule werden als freiwillige Zusatzleistungen in Zeugnis und Zeugnisergänzung (Diploma Supplement) ausgewiesen.

2. Further additional optional modules (graduate studies)

Beyond the additional modules mentioned in the preceding item, further modules not required for the Master's Degree can be completed. These are listed as additional optional modules ("Zusatzmodule")

on the Master's Degree certificate and the Transcript of Records, too. However, the respective grades will **not** count towards the overall grade of the Master's Degree. Pre-approval is required in case a module is not listed in this directory of modules.

Über die in dem vorhergehenden Punkt genannten Zusatzmodule hinaus können weitere, für den Masterabschluss nicht erforderliche Module als Zusatzmodule absolviert werden. Diese werden in Zeugnis und Zeugnisergänzung (Transcript of Records) als freiwillige Zusatzleistungen gelistet, jedoch bei der Berechnung des Gesamtergebnisses der Masterprüfung **nicht** berücksichtigt. Im Fall von Modulen, die nicht in diesem Modulverzeichnis genannt werden, muss die Belegung vorab genehmigt werden.

VII. 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:

VIII. 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.1206: Datenbanken** *English title: Databases*	5 C 3 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: 42 Stunden Selbststudium: 108 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).	3 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 **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 Mathematik
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 Mathematik
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:	**Arbeitsaufwand:**
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.	**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]:** Studiengangsbeauftragte(r)
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]:** Studiengangsbeauftragte/r
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]:** Studiengangsbeauftragte/r
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]:** Studiengangsbeauftragte/r
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:** Programme coordinator
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 **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]:** Studiengangsbeauftragte/r
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 Fach-publikum** *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 (ca. 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]:** Studiengangsbeauftragte/r
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]:** Studiengangsbeauftragte/r
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	4 C (Anteil SK: 4 C)
Modul B.Mat.0936: Medienbildung zu mathematischen Objekten und Problemen	2 SWS
English title: Media education for mathematical objects and problems	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Lernziele:	Präsenzzeit:
	28 Stunden
Nach erfolgreichem Absolvieren des Moduls verfügen die Studierenden über Kenntnisse des Medienunterstützen Lehrens und Lernens zu mathematischen Objekten und Problemen.	Selbststudium: 92 Stunden
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.	

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]:** Studiengangsbeauftragte/r
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]:** Studiengangsbeauftragte/r
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** | 3 C (Anteil SK: 3 C) |
| **Modul B.Mat.0950: Mitgliedschaft in der studentischen oder akademischen Selbstverwaltung** *English title: Membership in the student or academic self-government* | 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	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Studiengangsbeauftragte/r
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	3 C (Anteil SK: 3 C)
Modul B.Mat.0951: Ehrenamtliches Engagement in einem mathematischen Umfeld *English title: Civic engagement in a mathematical environment*	1 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	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]:** Studiengangsbeauftragte/r
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]:** Studiengangsbeauftragte/r
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	8 C (Anteil SK: 8 C)
Modul B.Mat.0970: Betriebspraktikum	
English title: Internship	

Lernziele/Kompetenzen:	Arbeitsaufwand:
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.	Präsenzzeit: 0 Stunden Selbststudium: 240 Stunden

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

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]: Studiengangsbeauftragte/r
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.1400: Grundlagen der Maß- und Wahrscheinlichkeits-theorie** *English title: Foundations of 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	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

> - kennen 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 abzählbar unendlichen Produkträumen aus;
> - formulieren wahrscheinlichkeitstheoretische Aussagen mit Wahrscheinlichkeitsräumen, Wahrscheinlichkeitsmaßen und Zufallsvariablen;
> - 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;
> - kennen charakteristische Funktionen und deren Anwendungen;
> - besitzen Grundkenntnisse über bedingte Wahrscheinlichkeiten und bedingte Erwartungswerte;
> - verwenden das schwache und starke Gesetz der großen Zahlen und den zentralen Grenzwertsatz.

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;
> - grundlegende Grenzwertsätze der Wahrscheinlichkeitstheorie zu verwenden.

Lehrveranstaltung: Maß- und Wahrscheinlichkeitstheorie (Vorlesung)	4 SWS
Lehrveranstaltung: Maß- und Wahrscheinlichkeitstheorie - Übung (Übung)	2 SWS

Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:**	9 C

B.Mat.1400.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	

Prüfungsanforderungen: Nachweis der Grundkenntnisse in Stochastik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiengangsbeauftragte/r
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.2100: Partielle Differenzialgleichungen** *English title: Partial differential equations*	9 C 6 SWS

| **Lernziele/Kompetenzen:**

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. | **Arbeitsaufwand:**
Präsenzzeit:
84 Stunden
Selbststudium:
186 Stunden |

Lehrveranstaltung: Partielle Differenzialgleichungen (Vorlesung)	4 SWS
Lehrveranstaltung: Partielle Differenzialgleichungen - Übung (Übung)	2 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

Prüfungsanforderungen: Nachweis der Grundkenntnisse über partielle Differenzialgleichungen	

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

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

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

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
Lehrveranstaltung: Funktionalanalysis - Übung (Übung)	2 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

Prüfungsanforderungen: Nachweis der Grundkenntnisse über Funktionalanalysis	

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

Deutsch	Studiengangsbeauftragte/r
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

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
Lehrveranstaltung: Funktionentheorie - Übung (Übung)	2 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

Prüfungsanforderungen: Nachweis der Grundkenntnisse in Funktionentheorie	

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

jedes Sommersemester	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.2200: Moderne Geometrie** *English title: Modern geometry*	9 C 6 SWS
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.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Vorlesung (Vorlesung)	4 SWS
Lehrveranstaltung: Übung *Angebotshäufigkeit:* jedes Wintersemester	2 SWS

Prüfung: Klausur (120 Minuten) **Prüfungsvorleistungen:** B.Mat.2200.Ue: Erreichen von mindestens 50% der Übungspunkte und zweimaliges Vorrechnen von Lösungen in den Übungen	9 C

Prüfungsanforderungen: Nachweis der Grundkenntnisse über Geometrie	

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

Sprache:	**Modulverantwortliche[r]:**
Deutsch	Studiengangsbeauftragte/r
Angebotshäufigkeit:	**Dauer:**
jedes Sommersemester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	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
Lehrveranstaltung: Zahlen und Zahlentheorie - Übung (Übung)	2 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

Prüfungsanforderungen: Nachweis der Grundkenntnisse der Zahlentheorie	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.0021, B.Mat.0022
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiengangsbeauftragte/r
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.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 - Übung	2 SWS
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

Prüfungsanforderungen: Nachweis weiterführender Kenntnisse in numerischer Mathematik	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.1300
Sprache: Deutsch	**Modulverantwortliche[r]:** Studiengangsbeauftragte/r
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]:** Studiengangsbeauftragte/r
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.3041: Overview on non-life insurance mathematics** *English title: Overview on non-life insurance mathematics*	3 C 2 SWS

Lernziele/Kompetenzen: **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.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Lecture course (Vorlesung)	2 SWS

Prüfung: Klausur (120 Minuten)	3 C

Prüfungsanforderungen: Basic knowledge on non-life insurance mathematics	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.1400
Sprache: Englisch	**Modulverantwortliche[r]:** Programme coordinator
Angebotshäufigkeit: keine Angabe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: **Instructor:** Lecturers at the Institute of Mathematical Stochastics

Georg-August-Universität Göttingen **Modul B.Mat.3042: Overview on life insurance mathematics** *English title: Overview on life insurance mathematics*	3 C 2 SWS

Lernziele/Kompetenzen: **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.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Lecture course (Vorlesung)	2 SWS

Prüfung: Klausur (120 Minuten)	3 C

Prüfungsanforderungen: Basic knowledge on life insurance mathematics	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.Mat.1400
Sprache: Englisch	**Modulverantwortliche[r]:** Programme coordinator
Angebotshäufigkeit: keine Angabe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** Bachelor: 4 - 6; Master: 1 - 4
Maximale Studierendenzahl: nicht begrenzt	

Bemerkungen: **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:	**Workload:** Attendance time: 56 h Self-study time: 124 h

- 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.

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:	Recommended previous knowledge:
none	B.Mat.1400
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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:** Programme coordinator
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: **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".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.1100, B.Mat.1200
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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:	Attendance time:
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	84 h Self-study time: 186 h

- 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".

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 WLH

Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes)	9 C

Examination prerequisites:

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

Examination requirements:

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

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.1100, B.Mat.1200
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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
Course: Exercise session (Exercise)	2 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

Examination requirements:	

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

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.1100, B.Mat.1200
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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	9 C
Module B.Mat.3114: Introduction to algebraic topology	6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time: 84 h
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.	Self-study time: 186 h

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".

Course: Lecture course (Lecture)	4 WLH

Course: Exercise session (Exercise)	2 WLH

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

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 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

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:	**Person responsible for module:**
English	Programme coordinator

Course frequency:	**Duration:**
not specified	1 semester[s]

Number of repeat examinations permitted:	**Recommended semester:**
twice	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 | 9 C |
| Module B.Mat.3121: Introduction to algebraic geometry | 6 WLH |

Learning outcome, core skills:	Workload:
Learning outcome:	**Workload:** Attendance time: 84 h Self-study time: 186 h

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".

| **Course: Lecture course** (Lecture) | 4 WLH |
| **Course: Exercise session** (Exercise) | 2 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	

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:** Programme coordinator
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:	**Workload:**
Learning outcome:	Attendance time:
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	84 h Self-study time: 186 h

- 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".

Course: **Lecture course** (Lecture)	4 WLH
Course: **Exercise session** (Exercise)	2 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
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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 WLH

Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes) **Examination prerequisites:**	9 C

B.Mat.3123.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 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	

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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: **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
Course: Exercise session (Exercise)	2 WLH

Examination: Written or oral examwritten 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	

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:** Programme coordinator
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:**
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. | **Workload:**
Attendance time:
84 h
Self-study time:
186 h |

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 WLH

Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes)	9 C
Examination prerequisites: B.Mat.3132.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

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:** Programme coordinator
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	9 C
Module B.Mat.3133: Introduction to numerics of partial differential equations	6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	84 h
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	Self-study time: 186 h

- 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".

Course: **Lecture course** (Lecture)	4 WLH
Course: **Exercise session** (Exercise)	2 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
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:** Programme coordinator
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
Course: **Exercise session** (Exercise)	2 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

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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:	**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 - 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".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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: Programme coordinator
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
Course: Exercise session (Exercise)	2 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
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:** Programme coordinator
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	9 C
Module B.Mat.3141: Introduction to applied and mathematical stochastics	6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	84 h
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	Self-study time: 186 h

- 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".

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 WLH

Examination: Written or oral examwritten examination (120 minutes) or oral examination (appr. 20 minutes)	9 C

Examination prerequisites:

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

Examination requirements:

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

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.1400
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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	9 C
	6 WLH
Module B.Mat.3142: Introduction to stochastic processes	

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	84 h
The successful completion of modules of the cycle "Stochastic processes" enables	Self-study time:
students to learn and apply methods, concepts, theories and proof techniques in the	186 h
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";

- explain basic ideas of proof in the area "Stochastic processes";
- illustrate typical applications in the area "Stochastic processes".

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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: Programme coordinator
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 economa-thematics**	9 C 6 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 • 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".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 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	

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:** Programme coordinator
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	9 C
Module B.Mat.3145: Introduction to statistical modelling and inference	6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time: 84 h
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	Self-study time: 186 h

Learning outcome continues:

- 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".

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 WLH

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

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:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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
Course: Exercise session (Exercise)	2 WLH

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

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:** Programme coordinator
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 | 9 C |
| Module B.Mat.3147: Introduction to statistical foundations of data science | 6 WLH |

Learning outcome, core skills:	Workload:
Learning outcome:	Attendance time:
	84 h
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	Self-study time: 186 h

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".

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 WLH

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

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: Programme coordinator
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:	**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 • 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.	**Attendance time:** 84 h **Self-study time:** 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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:	**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 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
Course: Exercise session (Exercise)	2 WLH

Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3312.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 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
Examination requirements:	

Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Differential geometry"

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3113
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3113 "Introduction to differential geometry"	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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
Course: Exercise session (Exercise)	2 WLH

Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3314.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C
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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 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

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:	**Person responsible for module:**
English	Programme coordinator

Course frequency:	**Duration:**
on an irregular basis	1 semester[s]

Number of repeat examinations permitted:	**Recommended semester:**
twice	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	9 C
Module B.Mat.3321: Advances in algebraic geometry	6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time: 84 h
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.	Self-study time: 186 h
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.	

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 WLH

Examination: Oral examination (approx. 20 minutes)	9 C
Examination prerequisites:	

B.Mat.3321.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

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:** Programme coordinator
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
Course: **Exercise session** (Exercise)	2 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

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 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

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

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3123

Language:	Person responsible for module:
English	Programme coordinator

Course frequency:	Duration:
Usually subsequent to the module B.Mat.3123 "Introduction to algebraic structures"	1 semester[s]

Number of repeat examinations permitted:	Recommended semester:
twice	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	9 C
Module B.Mat.3324: Advances in groups, geometry and dynamical systems	6 WLH

Learning outcome, core skills:	Workload:
Learning outcome:	Attendance time: 84 h
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.	Self-study time: 186 h

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.

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 WLH

Examination: Oral examination (approx. 20 minutes)	9 C

Examination prerequisites:	
B.Mat.3324.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

Examination requirements:	
Proof of advancement of knowledge and competencies acquired in the introductory module of the area "Groups, geometry and dynamical systems"	

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3124
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3124 "Introduction to groups, geometry and dynamical systems"	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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:**
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. | **Workload:**
Attendance time:
84 h
Self-study time:
186 h |

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 WLH

Examination: Oral examination (approx. 20 minutes)	9 C
Examination prerequisites: B.Mat.3331.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

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:** Programme coordinator
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:	**Workload:**
Learning outcome:	Attendance time:
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	84 h Self-study time: 186 h

- 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.

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 WLH

Examination: Oral examination (approx. 20 minutes) Examination prerequisites: B.Mat.3332.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

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: Programme coordinator
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	9 C
Module B.Mat.3333: Advances in numerics of partial differential equations	6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
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	84 h Self-study time: 186 h

- 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";

- apply methods of the area "Numerics of partial differential equations" to new problems in this area.

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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: Programme coordinator
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
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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	9 C
Module B.Mat.3337: Advances in variational analysis	6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time: 84 h
	Self-study time: 186 h

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:

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
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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	9 C
Module B.Mat.3338: Advances in image and geometry processing	6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time: 84 h
	Self-study time: 186 h

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";

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

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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: Programme coordinator
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
Course: Exercise session (Exercise)	2 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

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

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3139
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3139 "Introduction to scientific computing / applied mathematics"	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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
Course: Exercise session (Exercise)	2 WLH

Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** B.Mat.3341.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

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:** Programme coordinator
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: **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;	**Workload:** 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

Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 WLH

Examination: Oral examination (approx. 20 minutes)	9 C
Examination prerequisites:	
B.Mat.3344.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	

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

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3144

Language:	Person responsible for module:
English	Programme coordinator

Course frequency:	Duration:
Usually subsequent to the module B.Mat.3144 "Introduction to mathematical statistics"	1 semester[s]

Number of repeat examinations permitted:	Recommended semester:
twice	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:	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 - 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.	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 WLH

Examination: Oral examination (approx. 20 minutes) Examination prerequisites: B.Mat.3346.Ue: Achievement of at least 50% of the exercise points and presentation, twice, of solutions in the exercise sessions	9 C

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: Programme coordinator
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
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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: Kleine Leistung (max. 2 Seiten) oder Klausur (max. 45 Minuten), unbenotet **Prüfungsanforderungen:** Verständnis zentraler Begriffe, Probleme und Theorieansätze der theoretischen Philosophie und Fähigkeit, diese auf elementarem Niveau mindestens in kurzer Textform argumentativ verständlich darzulegen.	2 C

Lehrveranstaltung: 2. Proseminar zur theoretischen Philosophie **Es muss <u>eine</u> 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: Klausur (120 Minuten) **Prüfungsvorleistungen:** regelmäßige Teilnahme an einem Proseminar; kleinere Leistung mindestens in Textform (max. 2 S.; Protokoll, Kurzreferat o.ä.) **Prüfungsanforderungen:**	7 C

Verständnis zentraler Begriffe, Probleme und Theorieansätze der theoretischen Philosophie. Darstellung und Diskussion von Themen der theoretischen Philosophie auf elementarem Niveau mindestens in Textform.	
Prüfung: Essay (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

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: Kleine Leistung (max. 2 Seiten) oder Klausur (max. 45 Minuten), unbenotet **Prüfungsanforderungen:** Verständnis zentraler Begriffe, Probleme und Theorieansätze der praktischen Philosophie und Fähigkeit, diese auf elementarem Niveau mindestens in kurzer Textform 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: 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 praktischen Philosophie. Darstellung und Diskussion von Themen der praktischen Philosophie auf elementarem Niveau mindestens in Textform.	7 C

Prüfung: Essay (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

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, erste Bekanntschaft mit jeweils zentralen Themenbereichen und einzelnen Werken klassischer Autoren. 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: Kleine Leistung (max. 2 Seiten) oder Klausur (max. 45 Minuten), unbenotet **Prüfungsanforderungen:** Überblick über Epochen der Philosophiegeschichte und elementares Verständnis zentraler Themen und klassischer philosophischer Texte sowie Fähigkeit, diese auf elementarem Niveau mindestens in kurzer Textform 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: 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: Essay (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: Hausarbeit (max. 15 Seiten) **Prüfungsvorleistungen:**	7 C

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.

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Bernd Ludwig
Angebotshäufigkeit: jedes Semester; Einführungskurs bevorzugt im SoSe	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 2 - 3
Maximale Studierendenzahl: 100	

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 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	6 C
Modul B.WIWI-BWL.0014: Rechnungslegung der Unternehmung	4 SWS
English title: Financial Accounting	

Lernziele/Kompetenzen:	Arbeitsaufwand:
Gegenstand der Veranstaltung ist die Vermittlung der Grundlagen externer Rechnungslegung nach Maßgabe handelsrechtlicher und internationaler Vorschriften (International Financial Reporting Standards (IFRS)). Mit erfolgreichem Abschluss der Veranstaltung haben Studierende folgende Kompetenzen erworben: • Kenntnis der Grundzüge handelsrechtlicher und internationaler Rechnungslegung sowie markanter Unterschiede und grundlegender Entwicklungslinien, • Auswertung und Interpretation der entsprechenden Rechenwerke und Verwendung für analytische, entscheidungsunterstützende Zwecke.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Rechnungslegung der Unternehmung (Vorlesung)	2 SWS
Lehrveranstaltung: Rechnungslegung der Unternehmung (Übung)	2 SWS

Prüfung: Klausur (90 Minuten)	6 C

Prüfungsanforderungen:	
Von Studierenden wird der Nachweis der Kenntnis der Grundlagen der Rechnungslegung nach handelsrechtlichen Grundsätzen und nach International Financial Reporting Standards im Spannungsfeld nationaler Institutionen und internationaler Konvergenzbestrebungen erwartet. Dies umfasst auch die Lösung konkreter Fallbeispiele unter Einbeziehung handelsrechtlicher oder internationaler Rechnungslegungsvorschriften.	

Zugangsvoraussetzungen: keine	Empfohlene Vorkenntnisse: B.WIWI-OPH.0005 Jahresabschluss
Sprache: Deutsch	Modulverantwortliche[r]: Prof. Dr. Jörg-Markus Hitz
Angebotshäufigkeit: jedes Sommersemester	Dauer: 1 Semester
Wiederholbarkeit: zweimalig	Empfohlenes Fachsemester: 3 - 4
Maximale Studierendenzahl: nicht begrenzt	

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:	**Empfohlene Vorkenntnisse:**
keine	keine
Sprache:	**Modulverantwortliche[r]:**
Deutsch	Prof. Dr. Martin Balleer
Angebotshäufigkeit:	**Dauer:**
in der Regel jedes zweite Semester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	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:	Empfohlene Vorkenntnisse:
keine	B.WIWI-BWL.0005 Marketing
Sprache:	**Modulverantwortliche[r]:**
Deutsch	Prof. Dr. Waldemar Toporowski
Angebotshäufigkeit:	**Dauer:**
jedes Sommersemester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	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 UniVz.

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	8 C
Modul B.WIWI-OPH.0009: Recht	6 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Nach erfolgreichem Absolvieren des Moduls: • haben die Studierenden grundlegende Kenntnisse des Zivilrechts und des Handelsrechts erlangt, • haben die Studierenden gelernt, zwischen Verpflichtungsgeschäft und Verfügungsgeschäft sowie zwischen vertraglichen und deliktischen Ansprüchen zu differenzieren, • kennen die Studierenden die wesentlichen Vertragstypen, • kennen die Studierenden die dogmatischen Konzeptionen des Zivilrechts in ihrer systematischen, ideellen und praktischen Bedeutung, • kennen die Studierenden die Methoden der Gesetzesauslegung (Wortlaut, systematische, historische, teleologische Auslegung) und können diese anwenden, • können die Studierenden die Technik der Falllösung im Bereich des Zivilrechts anwenden, • sind die Studierenden in der Lage, die erworbenen Kenntnisse bei der Lösung einschlägiger Fälle umzusetzen und sich mit den aufgeworfenen Rechtsfragen kritisch auseinanderzusetzen.	Präsenzzeit: 84 Stunden Selbststudium: 156 Stunden

Lehrveranstaltung: Recht (Vorlesung)	4 SWS
Lehrveranstaltung: Recht (Übung)	2 SWS
Prüfung: Klausur (120 Minuten)	8 C

Prüfungsanforderungen:	
Durch die Modulprüfung weisen die Studierenden nach, dass sie: • grundlegende Kenntnisse im Zivil- und Handelsrecht aufweisen, • ausgewählte Tatbestände des Zivilrechts beherrschen, • die zugehörigen methodischen Grundlagen beherrschen und • systematisch an einen zivilrechtlichen Fall herangehen und diesen in vertretbarer Weise lösen können.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Joachim Münch
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 2
Maximale Studierendenzahl: nicht begrenzt	

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)	2 SWS
Inhalte: In den Übungen werden die Inhalte der Vorlesung anhand von Aufgaben wiederholt und vertieft.	

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	6 C
Modul B.WIWI-VWL.0002: Makroökonomik II	4 SWS
English title: Macroeconomics II	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Die Studierenden:	Präsenzzeit:
	56 Stunden
• verstehen die Zusammenhänge auf Arbeitsmärkten, kennen die Determinanten von Arbeitsangebot und Arbeitsnachfrage und können ein Arbeitsmarktgleichgewicht darstellen,	Selbststudium: 124 Stunden
• sind in der Lage, bekannte gesamtwirtschaftliche Modelle durch die arbeitsmarkttheoretischen Erkenntnisse zu erweitern und dadurch lang- und kurzfristige Wirkungen wirtschaftspolitischer Maßnahmen zu unterscheiden,	
• können die Zusammenhänge zwischen Inflation und Arbeitslosigkeit anhand der Phillips-Kurve darstellen und diese kritisch reflektieren,	
• sind mit verschiedenen Wachstumsmodellen vertraut und kennen die Bedeutung von Wachstum für eine Volkswirtschaft,	
• sind in der Lage, ein gesamtwirtschaftliches Modell durch die Beziehungen zum Ausland zu erweitern und anhand dieses Modells die Wirkung verschiedener wirtschaftspolitischer Maßnahmen zu diskutieren,	
• kennen die Eigenschaften verschiedener Währungssysteme und können deren Vor- und Nachteile unter Einbeziehung ihres Einflusses auf die Wirkung wirtschaftspolitischer Maßnahmen beurteilen.	

Lehrveranstaltung: Makroökonomik II (Vorlesung)	2 SWS
Inhalte:	
Die Vorlesung vertieft den Stoff des Moduls Makroökonomische Theorie I durch die Berücksichtigung verschiedener Erweiterungen. Einen Schwerpunkt bildet dabei die Diskussion arbeitsmarkttheoretischer Zusammenhänge, die in bekannte gesamtwirtschaftliche Modelle einbezogen werden, um kurz- und langfristige Wirkungen wirtschaftlicher Maßnahmen unterscheiden zu können. Weitere Schwerpunkte sind die Analyse von Wirtschaftswachstum sowie mikroökonomischer Fundierungen makroökonomischer Annahmen. Schließlich werden wirtschaftspolitische Maßnahmen in offenen Volkswirtschaften im klassischen und keynesianischen Kontext analysiert und deren Wirkung in verschiedenen Währungssystemen diskutiert. Aus diesen Überlegungen werden Aussagen über die Geeignetheit verschiedener Währungssysteme abgeleitet, wobei auch auf die Europäische Währungsunion eingegangen wird.	

Lehrveranstaltung: Makroökonomik II (Übung)	2 SWS
Inhalte:	
Im Rahmen der begleitenden Übung/Tutorium vertiefen die Studierenden die Kenntnisse aus der Vorlesung anhand ausgewählter theoretischer Fragestellungen.	

Prüfung: Klausur (90 Minuten)	6 C

Prüfungsanforderungen:	

- Nachweis von Kenntnissen über arbeitsmarkttheoretische Zusammenhänge und den Modifikationen gesamtwirtschaftlicher Modelle durch deren Berücksichtigung,
- Nachweis der Kenntnis und souveränen Handhabung neoklassischer und keynesianischer Gütermarkt-Hypothesen,
- die Studierenden sind in der Lage, die Zusammenhänge zwischen Inflation und Arbeitslosigkeit zu begründen, theoretisch darzustellen und zu diskutieren,außerdem kennen sie Wachstumsmodelle und deren Bedeutung für die Volkswirtschaften,
- Nachweis von Kenntnissen über die Wirkungsweise verschiedener Währungssysteme und einer Währungsunion,
- Nachweis der Kenntnis und souveränen Anwendung des Mundell-Fleming-Modells zur Analyse der Wirkungen verschiedener wirtschaftspolitischer Maßnahmen für eine offene Volkswirtschaft bei unterschiedlichen Wechselkurssystemen.

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	B.WIWI-OPH.0008 Makroökonomik I
Sprache:	**Modulverantwortliche[r]:**
Deutsch	Prof. Dr. Tino Berger, Prof. Dr. Krisztina Kis-Katos, Dr. Katharina Werner
Angebotshäufigkeit:	**Dauer:**
jedes Semester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	2 - 6
Maximale Studierendenzahl:	
nicht begrenzt	

Georg-August-Universität Göttingen	6 C
Modul B.WIWI-VWL.0005: Grundlagen der internationalen Wirtschaftsbeziehungen *English title: Introduction to International Economics*	4 SWS

Lernziele/Kompetenzen: Die Studierenden:	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
- 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, - ind 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.	

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. Tino Berger Prof. Dr. Udo Kreickemeier
Angebotshäufigkeit: jedes Semester	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:	**Modulverantwortliche[r]:**
Deutsch	Prof. Dr. Holger Strulik
	Dr. Katharina Werner
Angebotshäufigkeit:	**Dauer:**
jedes zweite Semester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	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: jedes Sommersemester	**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:	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 152 Stunden

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.

Lehrveranstaltung: Einführung in die Institutionenökonomik (Vorlesung) *Inhalte*:	2 SWS

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

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-VWL.0075: Dynamische Methoden in der Ökonomie** *English title: Economic Dynamics*	6 C 4 SWS

Lernziele/Kompetenzen: Nach Abschluss dieses Moduls: • haben die Studierenden ein grundlegendes Verständnis der dynamischen Prozesse in der Ökonomie, • sie machen sich mit den mathematischen Methoden vertraut, wenden diese zur Lösung ökonomischer Fragestellungen an und reflektieren kritisch die Methoden und Resultate.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Dynamische Methoden in der Ökonomie (Vorlesung)
Inhalte:
1) Differentialgleichungen
 	
    i. Existenz, Eindeutigkeit und weitere Eigenschaften von Lösungen
 	
    ii. Lineare Differentialgleichungen erster Ordnung
 	
    iii. Lösungsverfahren für Differentialgleichungen (u.a. Trennung der Variablen, Variation der Konstanten)
 	
    iv. Systeme linearer Differentialgleichungen
 	
    v. Differentialgleichungen höherer Ordnung
 	
    vi. Stabilität
 	
2) Dynamische Optimierung: Variationsrechnung und optimale Kontrolle
 	
    i. Notwendige und hinreichende Optimalitätsbedingungen
 	
    ii. Transversalitätsbedingungen
 	
    iii. Endlicher und unendlicher Zeithorizont
 	
    iv. Anwendungen in der Ökonomie (u.a. neoklassisches Wachstumsmodell, Extraktion von Ressourcen)
	2 SWS

Lehrveranstaltung: Dynamische Methoden in der Ökonomie (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: Mündliche Prüfung (20 Minuten) oder Klausur (90 Minuten)	6 C

Prüfungsanforderungen: Nachweis: • fundierter Kenntnisse der dynamischen Methoden in der Ökonomie, • von grundlegendem Verständnis der behandelten Modelle, • von der Fähigkeit zum selbständigen Lösen von Anwendungsbeispielen im Themenbereich der Vorlesung (theoretisch, graphisch und verbal).	

Zugangsvoraussetzungen:	Empfohlene Vorkenntnisse:
keine	B.WIWI-OPH.0002 Mathematik
Sprache:	**Modulverantwortliche[r]:**
Deutsch	Dr. Katharina Werner
Angebotshäufigkeit:	**Dauer:**
unregelmäßig	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	3 - 6
Maximale Studierendenzahl:	
nicht begrenzt	

Bemerkungen:
Studierende, die das Modul B.WIWI-VWL.0075 absolviert haben, können im Masterstudiengang das Modul M.WIWI-VWL.0160 nicht belegen.

Georg-August-Universität Göttingen	6 C
Modul B.WIWI-WB.0005: Heterodoxie in der VWL *English title: Heterodox Economics*	4 SWS

Lernziele/Kompetenzen: Nach Besuch der Veranstaltung sind die Teilnehmer_innen dazu in der Lage, die unterschiedlichen Ansätze der Wirtschaftswissenschaften bewerten und aufeinander beziehen zu können. Dieser allgemeine Überblick schafft ein Bewusstsein für Problembereiche der verschiedenen Ansätze und ermöglicht eine reflektierte Kontextualisierung.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Heterodoxie in der VWL (Vorlesung) *Inhalte*: Ziel der Veranstaltung ist die Betrachtung der Volkswirtschaftslehre aus einer pluralistischen Perspektive. Ausgehend von einer Standort-Bestimmung und einer geschichtlichen Fundierung der Ökonomik, soll die VWL wissenschaftstheoretisch durchleuchtet werden. Im Anschluss sollen alternative Herangehensweisen mit den klassischen Ansätzen kontrastiert werden und ihr Erklärungspotenzial kritisch hinterfragt werden.	2 SWS
Lehrveranstaltung: Heterodoxie in der VWL (Tutorium)	2 SWS

Prüfung: Klausur (90 Minuten)	6 C

Prüfungsanforderungen: Die Studierenden demonstrieren ein gutes Verständnis der im Unterricht präsentierten Inhalte. Sie sind in der Lage, vorgestellte Theorien darzustellen, zu vergleichen, kritisch zu hinterfragen und sie in den Kontext der wirtschaftswissenschaftlichen Debatte einzuordnen.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** B.WIWI-OPH.0007 Mikroökonomik I B.WIWI-OPH.0008 Makroökonomik I B.WIWI-VWL.0001 Mikroökonomik II B.WIWI-VWL.0002 Makroökonomik II
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Stephan Klasen Prof. Thomas Kneib
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:	**Arbeitsaufwand:** Präsenzzeit: 38 Stunden Selbststudium: 142 Stunden

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,
- in Gruppenarbeit mit Hilfe angeeigneter Kommunikations- und Organisationsfähigkeiten Aufgabenstellungen im Themenfeld der Vorlesung zu bearbeiten.

Lehrveranstaltung: Management der Informationssysteme (Vorlesung)	2 SWS

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)
- 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:** Drei erfolgreich testierte Bearbeitungen von Fallstudien.	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:	Empfohlene Vorkenntnisse:
keine	Modul B.WIWI-OPH.0003: Informations- und Kommunikationssysteme

Sprache:	**Modulverantwortliche[r]:**
Deutsch	Dr. Sebastian Hobert
Angebotshäufigkeit:	**Dauer:**
jedes Semester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	3 - 6
Maximale Studierendenzahl:	
nicht begrenzt	

| Georg-August-Universität Göttingen | 6 C |
| Modul B.WIWI-WIN.0002: Management der Informationswirtschaft
English title: Fundamentals of Information Management | 6 SWS |

Lernziele/Kompetenzen: Die Studierenden:	Arbeitsaufwand: Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden
• 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.	

Lehrveranstaltung: Management der Informationswirtschaft (Vorlesung)	2 SWS
Lehrveranstaltung: Methodische Übung Management der Informationswirtschaft (Übung)	2 SWS
Lehrveranstaltung: Inhaltliche Übung Management der Informationswirtschaft (Übung)	2 SWS

Prüfung: Klausur (90 Minuten) Prüfungsvorleistungen: siehe Bemerkungen	6 C

Prüfungsanforderungen: • Nachweis von Kenntnissen über Grundlagen der Informationswirtschaft, • Wissenschaftliche Bearbeitung von zwei Gruppenarbeiten in schriftlicher Form.	

Zugangsvoraussetzungen: keine	Empfohlene Vorkenntnisse: Orientierungsphase
Sprache: Deutsch	Modulverantwortliche[r]: Prof. Dr. Lutz M. 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.

Prüfungsvorleistung

Bearbeitung und Abgabe zweier Gruppenarbeiten im Rahmen der Übung. Nichtteilnahme/Abwesenheit bei der Erbringung von Prüfungsvorleistungen führt zum Ausschluss von der Prüfung. Die erbrachte Prüfungsvorleistung ist nicht auf kommende Semester übertragbar.

Georg-August-Universität Göttingen **Modul B.WIWI-WIN.0031: Design Science und Design Thinking** *English title: Design Science and Design Thinking*	6 C 2 SWS

Lernziele/Kompetenzen: Die Studierenden: • kennen und verstehen die Rolle und Bedeutung von Design in der Wirtschaft und Informatik, • kennen und verstehen die typische Design Science Forschungsmethodik, • kennen und verstehen Design Artefakte, Design Theorien und deren Beitrag zu Theorie und Praxis, • kennen und verstehen die Anwendungsfelder von Design Thinking in der Praxis, • können eigenständig Design Artefakte auf Basis von Nutzerforschung (bspw. Customer Journey) kreieren, prototypisch evaluieren und grundlegend in den Design-Diskurs einordnen, • analysieren und evaluieren wissenschaftliche Artikel hinsichtlich wissenschaftlicher und praxisrelevanter Fragestellungen.	**Arbeitsaufwand:** Präsenzzeit: 24 Stunden Selbststudium: 156 Stunden

Lehrveranstaltung: Design Science und Design Thinking (Vorlesung) *Inhalte*: **1. Einführung in Design Science** • Einführung in Design Science und die historische Entwicklung, • Einführung in den Design Diskurs im Kontext von Informationssystem(IS)-Forschung, • Darstellung von Design Science (Forschungs-)Prozessen und den Grundlagen von Design Theorien.	1 SWS
Lehrveranstaltung: Einführung in Design Thinking (Übung) *Inhalte*: • Einführung in den Design Thinking Prozess nach IDEO / Hasso Plattner School of Design Thinking, • Vermittlung von methodischen Kenntnissen für die einzelnen Design Thinking Phasen (Verstehen, Beobachten, Sichtweise definieren (Point of View), Ideen finden, Prototypen entwickeln, Testen), • eigenständiges Durchlaufen und Anwendung des Design Thinking Zyklus im Rahmen einer Gruppenarbeit. Vorlesung und Übung finden alternierend statt.	1 SWS

Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Eine aktive Teilnahme an den Übungen sowie die erfolgreiche wissenschaftliche Bearbeitung und Abgabe zweier Gruppenarbeiten im Rahmen der Übung. **Prüfungsanforderungen:** • Nachweis eines übergreifenden Verständnisses zu den vorgestellten Themen des Design Science und Design Thinking,	6 C

- eigenständige Reflexion zu Fragen der Design Science Forschung und zu der Anwendung des Design Thinking Prozesses in der Praxis,
- Nachweis des Verständnisses zentraler Begriffe, Prozesse und Theorien der Design Science Forschung und des Design Thinkings sowie die Fähigkeit zur kritischen Würdigung und Einordnung in verschiedenen Anwendungsfällen,
- Nachweis der kritischen Beurteilung von Forschungsansätzen in der Design Science Forschung,
- Verständnis der Vor- und Nachteile sowie Grenzen eines Einsatzes von Design Science Forschung und Design Thinking in der Wissenschaft und Praxis.

Prüfungsanforderungen:
- Nachweis eines übergreifenden Verständnisses zu den vorgestellten Themen des Design Science und Design Thinking,
- eigenständige Reflexion zu Fragen der Design Science Forschung und zu der Anwendung des Design Thinking Prozesses in der Praxis,
- Nachweis des Verständnisses zentraler Begriffe, Prozesse und Theorien der Design Science Forschung und des Design Thinkings sowie die Fähigkeit zur kritischen Würdigung und Einordnung in verschiedenen Anwendungsfällen,
- Nachweis der kritischen Beurteilung von Forschungsansätzen in der Design Science Forschung,
- Verständnis der Vor- und Nachteile sowie Grenzen eines Einsatzes von Design Science Forschung und Design Thinking in der Wissenschaft und Praxis.

Zugangsvoraussetzungen:	Empfohlene Vorkenntnisse:
keine	- Orientierungsphase abgeschlossen Es werden zu Kursbeginn vorausgesetzt: - Einschlägige Erfahrungen im Verfassen wissenschaftlicher Seminar- bzw. Hausarbeiten (bspw. durch die erfolgreiche Absolvierung eines Bachelor-Seminars oder einer Lehrveranstaltung mit integrierter Hausarbeit (z.B. Management der Informationswirtschaft)) - Mindestens gute Englischkenntnisse, da der wissenschaftliche Design Science und Design Thinking Diskurs nahezu ausschließlich englischsprachig ist und die Lektüre englischsprachiger Publikationen im Rahmen der Lehrveranstaltung notwendig ist
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Alfred B. Brendel
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 4 - 6
Maximale Studierendenzahl:	

nicht begrenzt	

Georg-August-Universität Göttingen **Modul M.Che.1311: Schwingungsspektroskopie und zwischenmolekulare Dynamik** *English title: Vibrational Spectroscopy and Intermolecular Dynamics*	6 C 4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
• Die Absolventinnen und Absolventen 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.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Vorlesung mit Übung: Schwingungsspektroskopie und zwischenmolekulare Dynamik	

Prüfung: Klausur (180 Minuten)	6 C

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: i.d.Regel alle zwei jahre	**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	6 C
Modul M.Che.1313: Elektronische Spektroskopie und Reaktionsdynamik	4 SWS
English title: Electronic Spectroscopy and Reaction Dynamics	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Die Absolventinnen und Absolventen 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.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Vorlesung mit Übung: Elektronische Spektroskopie und Reaktionsdynamik	

Prüfung: Klausur (180 Minuten)	6 C

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. Alec Wodtke
Angebotshäufigkeit: i.d.Regel alle 2 jahre	**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	6 C
Modul M.Che.1314: Biophysikalische Chemie	4 SWS
English title: Biophysical Chemistry	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Vorlesung mit Übungen Biophysikalische Chemie	4 SWS

Prüfung: Klausur (120 Minuten)	6 C

Prüfungsanforderungen:	
• Strukturen biologischer Makromoleküle aus spektroskopischen und mikroskopischen Daten ableiten können • Übertragung genereller physikochemischer Prinzipien, wie zum Beispiel der Reaktionsdynamik, (statistischen) Thermodynamik und Quantentheorie auf die Beschreibung biologischer Phänomene • Kenntnisse der wesentlichen Methoden, wie z.B. Streumethoden, spektroskopische Methoden (UV-Vis, Fluoreszenz, Lumineszenz, Circulardichroismus ATR-IR, NMR, ESR, …), kalorimetrischen und kolligativen Methoden	

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 4 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: 56 h Self-study time: 124 h

Course: Lecture Combined with Tutorial: Chemical Dynamics at Surfaces	

Examination: Written examination (180 minutes)	6 C

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: normally every 2 years	**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. Stephan Waack (Prof. Dr. Carsten Damm, Prof. Dr. Anita Schöbel, Prof. Dr. Florentin Andreas Wörgötter)
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen	6 C
Modul M.Inf.1141: Semistrukturierte Daten und XML	4 SWS
English title: Semistructured Data and XML	

Lernziele/Kompetenzen:	Arbeitsaufwand:
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.	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.1151: Specialisation Softwareengineering: Data Science and Big Data Analytics**	5 C 3 WLH

Learning outcome, core skills: The students - can define the terms data science, data scientist and big data, and acquire knowledge about the principle of data science and big data analytics - become acquainted with the life cycle of data science projects and know how the life cycle can be applied in practice - gain knowledge about a statistical and machine learning modelling system - gain knowledge about basic statistical tests and how to apply them - gain knowledge about clustering algorithms and how to apply them - gain knowledge about association rules and how to apply them - gain knowledge about regression techniques and how to apply them - gain knowledge about classification techniques and how to apply them - gain knowledge about text analysis techniques and how to apply them - gain knowledge about big data analytics with MapReduce - gain knowledge about advanced in-database analytics	**Workload:** Attendance time: 42 h Self-study time: 108 h

Course: Data Science and Big Data Analytics (Lecture, Exercise)	3 WLH
Examination: Klausur (90 Min.) oder mündliche Prüfung (ca. 20 Min.) **Examination prerequisites:** Successful completion of 50% of each exercise and the conduction of a small analysis project. **Examination requirements:** Data science, big data, analytics, data science life cycle, statistical tests, clustering, association rules, regression, classification, text analysis, in-database analytics.	5 C

Admission requirements: none	**Recommended previous knowledge:** Foundations of statistics and stochastic.
Language: English	**Person responsible for module:** Prof. Dr. Jens Grabowski
Course frequency: unregelmäßig	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Georg-August-Universität Göttingen	5 C
Module M.Inf.1171: Service-Oriented Infrastructures	3 WLH

Learning outcome, core skills:	**Workload:**
Successfully completing the module, students	Attendance time:
	42 h

Learning outcome, core skills:

Successfully completing the module, students

- understand basic web technologies (transfer protocols, markup languages, markup processing, RESTful and SOAP web services)
- understand virtualisation technologies (server, storage, and network virtualisation)
- understand Cloud computing (standards, APIs, management, service layers)
- understand security mechanisms for distributed systems (authentication, authorisation, certificates, public key infrastructures)
- understand data services (sharing, management, and analysis)
- understand Big Data technology (MapReduce)

On completion of this module students will have a good understanding of the fundamental and up-to-date concepts used in the context of service-oriented infrastructures. This basic knowledge can be leveraged by students to design, implement, and manage service-oriented infrastructures by themselves.

Workload:
Attendance time:
42 h
Self-study time:
108 h

Course: Service Computing (Lecture, Exercise)   3 WLH

Contents:

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 such as Facebook, Google, or Amazon 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 such as Dropbox, Evernote, and iTunes. These examples and many more services build on sophisticated service-oriented infrastructures. The key challenges of service-oriented infrastructures are related to scaling services. More specifically large service-oriented 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. IT management covers Cloud computing, and the virtualisation of computing, storage, and network resources. Cloud computing in specific is covered by the discussion of production-grade infrastructure-as-service and platform-as-a-service middlewares. IT management is covered by the discussion of deployment models, service level agreements, and security aspects. Programming models are covered by discussing RESTful and SOAP web-services, MapReduce, and OSGi.

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 service-oriented infrastructures.

Examination: Klausur (90 Min.) oder mündliche Prüfung (ca. 20 Min.) **Examination requirements:** • RESTful and SOAP web services • XML • Compute, storage, and network virtualisation • Infrastructure-as-a-service, platform-as-a-service, software-as-a-service • Characteristics of Cloud computing (NIST) • OSGi • MapReduce • iRODS • Service level agreements • Symmetric and asymmetric encryption (SSL, TLS) • Security certificates (X.509) • Public key infrastructures	5 C

Admission requirements: none	**Recommended previous knowledge:** • Programming basics in Java or a similar language • Basic understanding of operating systems and command line interfaces
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.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:	Recommended previous knowledge:
none	none
Language:	**Person responsible for module:**
English	Prof. Dr. Ramin Yahyapour
Course frequency:	**Duration:**
unregelmäßig	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	
Maximum number of students:	
30	

Georg-August-Universität Göttingen	5 C
Modul M.Inf.1181: Seminar NOSQL Databases	2 SWS
English title: Seminar NOSQL Databases	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Erwerb fortgeschrittener theoretischer und praktischer Kompetenzen in ausgewählten Gebieten der NOSQL-Datenbanken. Ausbau der Fähigkeiten zur Präsentation und Beurteilung wissenschaftlicher Ergebnisse und zur wissenschaftlichen Diskussion.	Präsenzzeit: 28 Stunden Selbststudium: 122 Stunden

Lehrveranstaltung: Seminar NOSQL Databases (Seminar)	2 SWS
Inhalte: Erarbeitung aktueller Themen im Bereich NOSQL-Datenbanken anhand von wissenschaftlichen Arbeiten sowie praktischer Umgang mit einem NOSQL-Datenbanksystem.	
Prüfung: Vortrag (ca. 45 Min.) mit schriftlicher Ausarbeitung (max. 10 Seiten) Prüfungsanforderungen: Eigenständiges Erarbeiten der Inhalte und Erstellen der Ausarbeitung sowie Halten des Vortrags.	5 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Dr. Lena Wiese
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 14	

Georg-August-Universität Göttingen	5 C
Modul M.Inf.1182: Seminar Knowledge Engineering	2 SWS
English title: Seminar Knowledge Engineering	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Erwerb fortgeschrittener Kompetenzen in ausgewählten Gebieten des Knowledge Engineering. Ausbau der Fähigkeiten zur Präsentation und Beurteilung wissenschaftlicher Ergebnisse und zur wissenschaftlichen Diskussion.	Präsenzzeit: 28 Stunden Selbststudium: 122 Stunden

Lehrveranstaltung: Seminar Knowledge Engineering (Seminar)	2 SWS
Inhalte: Erarbeitung aktueller Themen anhand von relevanten Originalarbeiten aus dem Bereich des Knowledge Engineering, der Datenmodellierung oder Wissensrepräsentation mit wechselnden Schwerpunkten (zum Beispiel Modellierung und Umsetzung von Datensicherheit oder Intelligente Informationssysteme).	
Prüfung: Vortrag (ca. 45 Min.) mit schriftlicher Ausarbeitung (max. 10 Seiten) **Prüfungsanforderungen:** Eigenständiges Erarbeiten der Inhalte und Erstellen der Ausarbeitung sowie Halten des Vortrags.	5 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Dr. Lena Wiese
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 14	

Georg-August-Universität Göttingen **Module M.Inf.1185: Sensor Data Fusion**	5 C 3 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 • explain the fundamentals of dynamic state estimation (including the Kalman filter) • formalize data fusion problems as state estimation problems • describe and model the most relevant sensors • define the most common discrete-time and continuous-time dynamic models • perform a time-discretization of continuous-time models • apply the Kalman filter to linear state estimation problems • explain and apply basic nonlinear estimation techniques such as the Extended Kalman filter (EKF) • assess the properties, advantages, and disadvantages of the discussed (nonlinear) estimators • deal with unknown correlations in data fusion • implement, simulate, and analyze data fusion problems in MATLAB • describe and implement basic algorithms for simultaneous localization and mapping (SLAM) in MATLAB • identify data fusion applications and assess the benefits of data fusion	**Workload:** Attendance time: 42 h Self-study time: 108 h

Course: Sensor Data Fusion (Lecture, Exercise)	3 WLH

Examination: Written exam (90 min.) or oral exam (approx. 20 min.) **Examination prerequisites:** Presentation of at least one exercise and active participation during the exercises. **Examination requirements:** Definition of data fusion; fundamentals of dynamic state estimation (including the Kalman filter); formalization of data fusion problems; typical sensor models; typical discrete-time and continuous-time dynamic models; discretization of continuous-time models; Extended Kalman filter (EKF); algorithms for dealing with unknown correlations in data fusion; basic algorithms for simultaneous localization and mapping (SLAM)	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.1187: Simulation-based Data Fusion and Analysis**	5 C 3 WLH

Learning outcome, core skills: This module introduces fundamental simulation-based algorithms for the Bayesian fusion and analysis of noisy data sets. After completion, the students are able to • describe the Bayesian approach to data fusion and analysis • set up probabilistic state space models for time series data • describe the concept of a recursive Bayesian state estimator • employ Monte Carlo simulation for Bayesian inference • explain and apply sequential Monte Carlo methods, i.e., particle filters, such as Sequential Importance Sampling (SIS) and Sequential Importance Resampling (SIR) • explain and apply Markov Chain Monte Carlo (MCMC) methods such as Metropolis-Hasting and Gibbs sampling • describe the Bayesian interpretation of the Kalman filter • apply simulation-based implementations of the Kalman filter such as the Unscented Kalman Filter (UKF) and the Ensemble Kalman filter (EnKF) • employ Monte Carlo simulation for inference in probabilistic graphical models • explain Rao-Blackwellization and apply it to Simultaneous Localization and Mapping (SLAM) • assess the properties, advantages, and disadvantages of simulation-based techniques • apply the above concepts in the context of machine learning, computer vision, robotics, object tracking, and data science	**Workload:** Attendance time: 42 h Self-study time: 108 h

Course: Simulation-based Data Fusion and Analysis (Lecture, Exercise)	3 WLH

Examination: Written exam (90 min.) or oral exam (approx. 20 min.) **Examination prerequisites:** Presentation of at least one exercise and active participation during the exercises. **Examination requirements:** Probabilistic state space models for time series data; recursive Bayesian state estimator; Monte Carlo simulation; Sequential Monte Carlo methods (particle filters); Sequential Importance Sampling (SIS) and Sequential Importance Resampling (SIR); Markov Chain Monte Carlo (MCMC) methods such as Metropolis-Hasting and Gibbs sampling; simulation-based implementations of the Kalman filter; Application of Monte Carlo simulation for inference in probabilistic graphical models; Rao-Blackwellization.	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 **Modul M.Inf.1210: Seminar Algorithmische Methoden und theoretische Konzepte** *English title: Seminar on Algorithmic Methods and Theoretical Concepts in Computer Science*	5 C 2 SWS

Lernziele/Kompetenzen: Erwerb von Kompetenzen bei der selbständigen Erarbeitung und Präsentation von speziellen, forschungsbezogenen Themen zur Theoretischen Informatik und den Algorithmischen Methoden. Beispiele sind Probabilistische Datenmodelle, ihre mathematischen Grundlagen und ihre algorithmische Unterstützung, theoretische Grundlagen der Anwendung Informationstheoretischer Methoden in der Informatik, Methoden der Mustererkennung und des algorithmischen Lernens und ihrer Anwendungen. Überblick über die Modulinhalte: Aktuelle Originalarbeiten aus dem Bereich der theoretischen Informatik und algorithmischer Methoden.	**Arbeitsaufwand:** Präsenzzeit: 28 Stunden Selbststudium: 122 Stunden

Lehrveranstaltung: Algorithmische Methoden und theoretische Konzepte (Seminar) *Inhalte*: Aktuelle Originalarbeiten aus dem Bereich der theoretischen Informatik und algorithmischer Methoden.	2 SWS
Prüfung: Vortrag (ca. 45 Min.) mit schriftlicher Ausarbeitung (max. 10 Seiten) **Prüfungsanforderungen:** Nachweis über den Erwerb von Kompetenzen bei der selbständigen Erarbeitung und Präsentation von forschungsbezogenen Themen zu den Algorithmischen Methoden und fortgeschrittenen theoretischen Konzepten in der Informatik oder einer der Angewandten Informatiken.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Stephan Waack (Prof. Dr. Carsten Damm)
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 14	

Georg-August-Universität Göttingen	6 C
Modul M.Inf.1211: Probabilistische Datenmodelle und ihre Anwendungen *English title: Probabilistic Data Models and Applications*	4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
In dem Modul erwerben Studierende spezialisierte Kenntnisse zu Auswahl, Entwurf und Anwendungen von Modellen, für die die (parametrisierte) Zufälligkeit der Daten eine wesentliche Komponente der Modellierung ist. Überblick über die Modulinhalte: Zu verarbeitende Daten in verschiedensten Anwendungsbreichen (z. B. Bioinformatik) unterliegen meist statistischen Gesetzmäßigkeiten. Das Modul ist fokussiert auf Methoden zur Erkennung und algorithmischen Ausnutzung solcher typischen Muster durch geeignete probabilistische Modellierung der Daten und auf die Schätzung der Modellparameter. z. B. Vorlesung Algorithmisches Lernen, Vorlesung Datenkompression und Informationstheorie, Probabilistische Datenmodelle in der Angewandten Informatik.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Vorlesungen, Übungen und Seminare zu den vorgenannten Themen	
Prüfung: Klausur (60 Min.) oder mündliche Prüfung (ca. 20 Min.) **Prüfungsanforderungen:** Nachweis über den Erwerb spezialisierter Kenntnisse und Fähigkeiten zu probabilistischen Datenmodellen, der Komplexität ihrer algorithmischen Unterstützung und ggf. ihrer Anwendung in einer der Angewandten Informatiken oder einem Anwendungsbereich.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Stephan Waack (Prof. Dr. Carsten Damm)
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Inf.1213: Algorithmisches Lernen und Mustererkennung** *English title: Algorithmic Learning and Pattern Recognition*	6 C 4 SWS

Lernziele/Kompetenzen: Es werden spezialisierte Kompetenzen im Bereich des algorithmischen Lernens und der Mustererkennung vermittelt. Verständnis der theoretischen Grundlagen und der Probleme bei praktischen Anwendungen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Algorithmisches Lernen (Vorlesung, Übung) *Inhalte*: Es werden die Grundlagen des Algorithmischen Lernens vermittelt, prinzipielle Schranken und Möglichkeiten aufgezeigt und einige spezielle Ansätze diskutiert wie z. B. Grundlagen des PAC-Lernens und des PAC-Lernens mit Rauschen auf der Klassifikation. Schlüsselbegriffe wie VC Dimension und Rademacher-Komplexität von Hypothesenklassen die es ermöglichen, sowohl Möglichkeiten als auch Grenzen der Lernbarkeit zu verstehen.	4 SWS
Prüfung: Klausur (60 Min.) oder mündliche Prüfung (ca. 20 Min.) **Prüfungsanforderungen:** Nachweis über den Erwerb spezialisierter anwendungsorientierter Kenntnisse und Kompetenzen aus dem Bereich des algorithmischen Lernens und der Mustererkennung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Stephan Waack (Prof. Dr. Carsten Damm)
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Inf.1216: Datenkompression und Informationstheorie** *English title: Data Compression and Information Theory*	6 C 4 SWS

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	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Datenkompression und Informationstheorie (Vorlesung, Übung)	4 SWS

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	6 C

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:	**Recommended previous knowledge:**
none	• 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 **Modul M.Inf.1268: Informationstheorie** *English title: Information Theory*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Die Studierenden

- kennen die mathematische Grundlagen der Informationstheorie
- beherschen die grundlegenden Begriffe der Informationstheorie
- beherrschen die zentralen Begriffe und Verfahren der Datenkompression
- kennen grundlegende Begriffe und Aussagen zur Kanalkapazität
- kennen grundlegende Begriffe und Aussagen zur Kolmogorov-Komplexität

Lehrveranstaltung: Elements of Information Theory (Vorlesung, Übung)	4 SWS
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.	6 C

- Kenntnisse von Grundbegriffen wie Entropie, relative Entropie, wechselseitige Information
- asymptotische Äquipartitionseigenschaft und Typtheorie
- Entropierate stochastischer Prozesse
- Grundlagen der Datenkompression einschließlich ihrer Bezüge zur Spieltheorie
- Kanalkapazität und Kanalcodierungssatz
- Grundbegriffe der Kolmogorov-Komplexität

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Stephan Waack
Angebotshäufigkeit: unregelmäßig	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Module M.Inf.1281: NOSQL Databases**	6 C 4 WLH

Learning outcome, core skills: Learning how to store arbitrary documents, objects of programming languages, XML data and graphs in native databases; and comparison to storing these data in relational databases. Getting to know novel requirements for database management systems like flexible update and query behavior and distributed data on multiple servers.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: NOSQL Databases (Lecture, Exercise) *Contents*: The lecture covers for example graph databases, object databases , XML databases, key-value stores, and column-based databases, as well as concepts of distributed data management.	4 WLH
Examination: Written exam (90 minutes) or oral exam (approx. 20 minures) **Examination prerequisites:** Successful completion of a small database project (presentation and report) and active participation in the exercise sessions. **Examination requirements:** Presenting concepts, data models and storage mechanisms of the different NOSQL databases; explaining differences to the relational model. Showing basic knowledge of NOSQL query languages and access models. Explaining concepts of distributed database systems.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Lena Wiese
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 50	

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:** keine
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 Informations-systeme** *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: • Data structures and algorithms • Programming in C(/C++)	**Recommended previous knowledge:** • Parallel Computing • Computer architecture • Basic knowledge of computer networks • Basic know-how of computing clusters

Language:	Person responsible for module:
English	Prof. Dr. Ramin Yahyapour
Course frequency:	**Duration:**
unregelmäßig	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	
Maximum number of students:	
20	

Georg-August-Universität Göttingen **Module M.Mat.0731: Advanced practical course in scientific computing**	10 C 4 WLH

Learning outcome, core skills:	**Workload:**
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.	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:** Programme coordinator
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:	**Workload:**
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.	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:** Programme coordinator
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

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:** Programme coordinator
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
Course: Functional analysis / Partial differential equations - exercise session (Exercise)	2 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
Examination requirements:	

Proof of the advanced knowledge about functional analysis or partial differential equations	

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.0021, B.Mat.0022, B.Mat.1100
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
each summer semester	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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
Course: Exercise session (Exercise)	2 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

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:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
once a year	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.3140: Mathematical statistics	9 C 6 WLH

Learning outcome, core skills:	**Workload:**
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.	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
Course frequency:	**Duration:**

once a year	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: **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".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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	9 C
Module M.Mat.4512: Specialisation in analysis of partial differential equations	6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time: 84 h
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	Self-study time: 186 h

- 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".

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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:	**Recommended previous knowledge:**
none	B.Mat.3312

Language:	**Person responsible for module:**
English	Programme coordinator

Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3312 "Advances in analysis of partial differential equations"	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 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
Course: Exercise session (Exercise)	2 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
Examination requirements:	

Proof of the acquisition of special skills and the mastery of special knowledge in the area "Differential geometry"

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3313
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3313 "Advances in variational analysis"	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 Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4514: Specialisation 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

• enhance concepts and methods for special problems and applications in the area "Algebraic topology";
• prepare substantial ideas of proof in the area "Algebraic topology". | **Workload:**
Attendance time:
84 h
Self-study time:
186 h |

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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	

Examination requirements:	
Proof of the acquisition of special skills and the mastery of special knowledge in the area "Algebraic topology"	

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3314
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3314 "Advances in algebraic topology"	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 Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4515: Specialisation in mathematical methods in physics**	9 C 6 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 • 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".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

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	Programme coordinator
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
Course: Exercise session (Exercise)	2 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	

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 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
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: Programme coordinator
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
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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

Georg-August-Universität Göttingen **Module M.Mat.4524: Specialisation in groups, geometry and dynamical systems**	9 C 6 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 - 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".	Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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	
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:** Programme coordinator
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
Course: **Exercise session** (Exercise)	2 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

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:** Programme coordinator
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:**
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". | **Workload:**
Attendance time:
84 h
Self-study time:
186 h |

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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

Examination requirements:

Proof of the acquisition of special skills and the mastery of special knowledge in the
area "Inverse problems"

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3331

Language:	**Person responsible for module:**
English	Programme coordinator

Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3331 "Advances in inverse problems"	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	9 C
Module M.Mat.4532: Specialisation in approximation methods	6 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	84 h
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	Self-study time: 186 h

- 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".

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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	

Examination requirements:	
Proof of the acquisition of special skills and the mastery of special knowledge in the area "Approximation methods"	

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3332

Language:	Person responsible for module:
English	Programme coordinator

Course frequency:	Duration:
Usually subsequent to the module B.Mat.3332 "Advances in approximation methods"	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.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
Course: Exercise session (Exercise)	2 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

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: Programme coordinator
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
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".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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
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:** Programme coordinator
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:**
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

- 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
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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:	**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 • 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".	Attendance time: 84 h Self-study time: 186 h

Course: **Lecture course** (Lecture)	4 WLH
Course: **Exercise session** (Exercise)	2 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

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:** Programme coordinator
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
Course: Exercise session (Exercise)	2 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

Examination requirements: Proof of the acquisition of special skills and the mastery of special knowledge in the area "Scientific computing / applied mathematics	

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3339
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3339 "Advances in scientific computing / applied mathematics"	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.4541: Specialisation 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 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".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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	

Examination requirements:	
Proof of the acquisition of special skills and the mastery of special knowledge in the area "Applied and mathematical stochastics"	

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3341
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3341 "Advances in applied and mathematical stochastics"	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 Mathematical Stochastics

| Georg-August-Universität Göttingen | 9 C |
| Module M.Mat.4542: Specialisation in stochastic processes | 6 WLH |

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	84 h
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	Self-study time: 186 h

- 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

- 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
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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 econo-mathematics**	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
Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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
Course: **Exercise session** (Exercise)	2 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

Examination requirements:

Proof of the acquisition of special skills and the mastery of special knowledge in the area "Mathematical statistics"

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3344

Language:	**Person responsible for module:**
English	Programme coordinator

Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3344 "Advances in mathematical statistics"	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 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
Course: Exercise session (Exercise)	2 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

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:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3345 "Advances in statistical modelling and inference"	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 Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4546: Specialisation 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 • enhance concepts and methods for special problems and applications in the area "Multivariate statistics"; • prepare substantial ideas of proof in the area "Multivariate statistics".	**Workload:** Attendance time: 84 h Self-study time: 186 h

Course: Lecture course (Lecture)	4 WLH
Course: Exercise session (Exercise)	2 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	

Examination requirements:	
Proof of the acquisition of special skills and the mastery of special knowledge in the area "Multivariate statistics"	

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3346
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module B.Mat.3346 "Advances in multivariate statistics"	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 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

Course: Exercise session (Exercise)	2 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

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:** Programme coordinator
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: **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".	**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 "Analytic number theory"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3311
Language: English	**Person responsible for module:** Programme coordinator

Course frequency:	**Duration:**
Usually subsequent to the module M.Mat.4511 "Specialisation in analytic number theory"	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 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:**
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". | **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 "Analysis of partial differential equations"	

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3312
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module M.Mat.4512 "Specialisation in analysis of partial differential equations"	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 Mathematical Institute

Georg-August-Universität Göttingen	6 C
Module M.Mat.4613: Aspects of differential geometry	4 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
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	56 h Self-study time: 124 h

- 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".

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:	**Recommended previous knowledge:**
none	B.Mat.3313
Language:	**Person responsible for module:**

English	Programme coordinator
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:	Attendance time: 56 h Self-study time: 124 h

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

- conduct scholarly debates about problems of the area "Algebraic topology";
- carry out scientific work under supervision in the area "Algebraic topology".

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:	Recommended previous knowledge:
none	B.Mat.3314
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module M.Mat.4514 "Specialisation in algebraic topology"	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 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:** Programme coordinator
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:	Attendance time: 56 h Self-study time: 124 h
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"".	

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:	Recommended previous knowledge:
none	B.Mat.3321
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module M.Mat.4521 "Specialisation in algebraic geometry"	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 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: Programme coordinator
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 | 6 C |
| Module M.Mat.4623: Aspects of algebraic structures | 4 WLH |

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	56 h
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.	Self-study time: 124 h

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".

| **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:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module M.Mat.4523 "Specialisation in Variational Analysis"	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 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:**
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". | **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 "Groups, geometry and dynamical systems"

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3324
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module M.Mat.4524 "Specialisation in groups, geometry and dynamical systems"	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 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:** Programme coordinator
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: Programme coordinator
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:	Attendance time: 56 h
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	Self-study time: 124 h

- 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".

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:** Programme coordinator
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 diffe- rential 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:** Programme coordinator
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	6 C
	4 WLH
Module M.Mat.4634: Aspects of optimisation	

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	56 h
The successful completion of modules of the cycle "Optimisation" enables students to	Self-study time:
learn methods, concepts, theories and applications in the area of "Optimisation", so the	124 h

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".

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: Programme coordinator
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 | 6 C |
| Module M.Mat.4637: Aspects of variational analysis | 4 WLH |

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	56 h
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	Self-study time: 124 h

- 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:

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:	Recommended previous knowledge:
none	B.Mat.3337
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module M.Mat.4537 "Specialisation in Variational Analysis"	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.4638: Aspects of image and geometry processing**	6 C 4 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 • 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".	**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 "Image and geometry processing"	

Admission requirements: none	Recommended previous knowledge: B.Mat.3338
Language: English	**Person responsible for module:** Programme coordinator
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	Programme coordinator
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:**	**Workload:** Attendance time: 56 h Self-study time: 124 h

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".

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:	**Recommended previous knowledge:**
none	B.Mat.3341
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module M.Mat.4541 "Specialisation in applied and mathematical stochastics"	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 Mathematical Stochastics

Georg-August-Universität Göttingen **Module M.Mat.4642: Aspects of stochastic processes**	6 C 4 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: 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: Programme coordinator
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 economa-thematics**	6 C 4 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 • 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".	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:** Programme coordinator
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:
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". | **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 statistics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3344
Language: English	**Person responsible for module:** Programme coordinator
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:** Programme coordinator
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:	**Recommended previous knowledge:**
none	M.Mat.4546
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
Usually subsequent to the module M.Mat.4546 "Specialisation in multivariate statistics"	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 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:**
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". | **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 foundations of data science"	

Admission requirements: none	Recommended previous knowledge: M.Mat.4547
Language: English	Person responsible for module: Programme coordinator
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:** Programme coordinator
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	3 C
Module M.Mat.4712: Special course in analysis of partial differential equations	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	28 h
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	Self-study time: 62 h

- 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.

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:	Recommended previous knowledge:
none	B.Mat.3312
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	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 Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4713: Special course in 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

• 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. | **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 "Differential geometry"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3313

Language:	**Person responsible for module:**
English	Programme coordinator

Course frequency:	**Duration:**
not specified	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 Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4714: Special course in 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 • 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.	**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 topology"	

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3314

Language:	Person responsible for module:
English	Programme coordinator

Course frequency:	Duration:
not specified	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 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:** Programme coordinator
Course frequency: not specified	**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 Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4721: Special course in algebraic geometry**	3 C 2 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"; • become acquainted with special problems in the area "Algebraic geometry" 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 geometry"

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3321
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	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 Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4722: Special course in algebraic number theory**	3 C 2 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"; • become acquainted with special problems in the area "Algebraic 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 "Algebraic number theory	

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3322
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	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 Mathematical Institute

Georg-August-Universität Göttingen **Module M.Mat.4723: Special course in 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

• 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. | **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 structures"	

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3323
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	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 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:	Recommended previous knowledge:
none	B.Mat.3324
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	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 Mathematical Institute

Georg-August-Universität Göttingen	3 C
Module M.Mat.4725: Special course in non-commutative geometry	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time: 28 h
	Self-study time: 62 h

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;

- 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:** Programme coordinator
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	3 C
Module M.Mat.4731: Special course in inverse problems	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	28 h
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	Self-study time: 62 h
- 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.	

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:** Programme coordinator
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:	**Recommended previous knowledge:**
none	B.Mat.3332
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	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.4733: Special course in 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

• 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. | **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 Numerical nethods of partial differential equations"	

Admission requirements: none	Recommended previous knowledge: B.Mat.3333
Language: English	Person responsible for module: Programme coordinator
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	3 C
Module M.Mat.4734: Special course in optimisation	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:

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.

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 "Optimisation"	

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3334
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
on an irregular basis	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	3 C
Module M.Mat.4737: Special course in variational analysis	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	28 h
The successful completion of modules of the cycle "Variational analysis" enables	Self-study time:
students to learn methods, concepts, theories and applications in variational analysis	62 h
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:

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:	Recommended previous knowledge:
none	B.Mat.3337
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	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.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:	**Recommended previous knowledge:**
none	B.Mat.3338
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	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.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:** Programme coordinator

Course frequency:	Duration:
not specified	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.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:	Recommended previous knowledge:
none	B.Mat.3341
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	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 Mathematical Statistics

Georg-August-Universität Göttingen **Module M.Mat.4742: Special course in stochastic processes**	3 C 2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	28 h
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	Self-study time: 62 h

- 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";

- 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:** Programme coordinator
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 econo-mathematics**	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:** Programme coordinator
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:** Programme coordinator
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:** Programme coordinator
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:	**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 • 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:	Recommended previous knowledge:
none	B.Mat.3346

Language:	Person responsible for module:
English	Programme coordinator

Course frequency:	Duration:
not specified	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 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:**
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. | **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 foundations of data science"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3347
Language: English	**Person responsible for module:** Programme coordinator
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	Programme coordinator
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:	**Recommended previous knowledge:**
none	B.Mat.3312
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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:	Workload:
Learning outcome:	Attendance time:
	28 h
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	Self-study time: 62 h

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.

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:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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:	**Workload:**
Learning outcome:	Attendance time: 28 h
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.	Self-study time: 62 h

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.

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:	Recommended previous knowledge:
none	B.Mat.3314
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	Master: 1 - 4
Maximum number of students:	
not limited	

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

Georg-August-Universität Göttingen	3 C
Module M.Mat.4815: Seminar on mathematical methods in physics	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time: 28 h
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.	Self-study time: 62 h

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.

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 "Mathematical methods in physics"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3315
Language: English	**Person responsible for module:** Programme coordinator
Course frequency: not specified	**Duration:** 1 semester[s]

Number of repeat examinations permitted:	**Recommended semester:**
twice	Master: 1 - 4
Maximum number of students:	
not limited	

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

Georg-August-Universität Göttingen	3 C
Module M.Mat.4821: Seminar on algebraic geometry	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	28 h
In the modules of the cycle "Algebraic geometry" students get to know the most	Self-study time:
important classes of algebraic varieties and schemes as well as the tools for studying	62 h
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.	

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 geometry"

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3321
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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

Learning outcome, core skills:	**Workload:**
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.	**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 number theory"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3322
Language: English	**Person responsible for module:** Programme coordinator
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	3 C
Module M.Mat.4823: Seminar on algebraic structures	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	28 h
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.	Self-study time: 62 h
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.	

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 structures"

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3323
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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: **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.	**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 "Groups, geometry and dynamical systems"

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3324
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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.4825: Seminar on 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;	**Workload:** Attendance time: 28 h Self-study time: 62 h

- 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:** Programme coordinator
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	3 C
Module M.Mat.4831: Seminar on inverse problems	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time: 28 h
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	Self-study time: 62 h

- 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.

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:	**Recommended previous knowledge:**
none	B.Mat.3331
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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:	**Recommended previous knowledge:**
none	B.Mat.3332

Language:	**Person responsible for module:**
English	Programme coordinator

Course frequency:	**Duration:**
not specified	1 semester[s]

Number of repeat examinations permitted:	**Recommended semester:**
twice	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 | 3 C |
| Module M.Mat.4833: Seminar on numerical methods of partial differential equations | 2 WLH |

Learning outcome, core skills:	Workload:

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:** Programme coordinator
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

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 • become acquainted with a mathematical topic in the area "Optimisation" 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 "Optimisation"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3334
Language: English	**Person responsible for module:** Programme coordinator
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:** Programme coordinator
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

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 • 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.	**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 "Image and geometry processing"	

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3338
Language: English	**Person responsible for module:** Programme coordinator
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:	**Person responsible for module:**

English	Programme coordinator
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	3 C
Module M.Mat.4841: Seminar on applied and mathematical stochastics	2 WLH

Learning outcome, core skills:	Workload:
Learning outcome:	Attendance time: 28 h
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	Self-study time: 62 h

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.

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 "Applied and mathematical stochastics"

Admission requirements: none	**Recommended previous knowledge:** B.Mat.3341
Language: English	**Person responsible for module:** Programme coordinator
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	**Workload:** 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:** Programme coordinator
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:** Programme coordinator
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: **Learning outcome:**	**Workload:** Attendance time: 28 h Self-study time: 62 h

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.

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:	**Recommended previous knowledge:**
none	B.Mat.3344
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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	3 C
Module M.Mat.4845: Seminar on statistical modelling and inference	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	28 h
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	Self-study time: 62 h
• 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.	

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 "Statistical modelling and inference"	

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3345
Language:	**Person responsible for module:**
English	Programme coordinator
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

Georg-August-Universität Göttingen **Module M.Mat.4846: 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

• become acquainted with a mathematical topic in the area "Multivariate statistics" 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 "Multivariate statistics"	

Admission requirements:	**Recommended previous knowledge:**
none	B.Mat.3346
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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: **Learning outcome:**	**Workload:** Attendance time: 28 h Self-study time: 62 h

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

- 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.

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 "Statistical foundations of data science"	

Admission requirements:	Recommended previous knowledge:
none	B.Mat.3347
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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	3 C
Module M.Mat.4911: Advanced seminar on analytic number theory	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	28 h
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	Self-study time: 62 h
• 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.	

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 "Analytic number theory"	

Admission requirements:	**Recommended previous knowledge:**
none	M.Mat.4511
Language:	**Person responsible for module:**

English	Programme coordinator
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:** Programme coordinator
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:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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:**	**Workload:** Attendance time: 28 h Self-study time: 62 h

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.

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 topology"	

Admission requirements: none	Recommended previous knowledge: M.Mat.4514
Language: English	**Person responsible for module:** Programme coordinator
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	3 C
Module M.Mat.4915: Advanced seminar on mathematical methods in physics	2 WLH

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time: 28 h
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.	Self-study time: 62 h
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.	

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:** Programme coordinator
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:	Recommended previous knowledge:
none	M.Mat.4521
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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

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	**Workload:** Attendance time: 28 h Self-study time: 62 h

- 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.

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:** Programme coordinator
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:	Recommended previous knowledge:
none	M.Mat.4523
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	Master: 1 - 4
Maximum number of students:	
not limited	

Additional notes and regulations:

Instructor: Lecturers at the Mathematical Institute

| Georg-August-Universität Göttingen | 3 C |
| Module M.Mat.4924: Advanced seminar on groups, geometry and dynamical systems | 2 WLH |

Learning outcome, core skills:	Workload:
Learning outcome:	Attendance time: 28 h
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.	Self-study time: 62 h

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.

| 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 "Groups, geometry and dynamical systems"

Admission requirements:	Recommended previous knowledge:
none	M.Mat.4524

Language:	Person responsible for module:
English	Programme coordinator

Course frequency:	Duration:
not specified	1 semester[s]

Number of repeat examinations permitted:	Recommended semester:
twice	Master: 1 - 4

Maximum number of students:	
not limited	

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

Georg-August-Universität Göttingen	3 C
	2 WLH
Module M.Mat.4925: Advanced seminar on non-commutative geometry	

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	28 h
In the modules of the cycle "Non-commutative geometry" students get to know the	Self-study time:
conception of space of non-commutative geometry and some of its applications in	62 h
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;

- 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:** Programme coordinator
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.4931: Advanced 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

• present a mathematical topic of current research interest in the area "Inverse problems" 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:**	3 C

Participation in the advanced seminar	

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:** Programme coordinator
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:**
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. | **Workload:**
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:	**Recommended previous knowledge:**
none	M.Mat.4532
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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.4933: Advanced seminar on 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 - 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.	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 "Numerical methods of partial differential equations"	

Admission requirements: none	Recommended previous knowledge: M.Mat.4533
Language: English	**Person responsible for module:** Programme coordinator
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:	**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 - 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:** Programme coordinator
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 | 3 C |
| Module M.Mat.4937: Advanced seminar on variational analysis | 2 WLH |

Learning outcome, core skills:	**Workload:**
Learning outcome:	Attendance time:
	28 h

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:

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:** Programme coordinator
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:** Programme coordinator
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:**
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. | **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 "Scientific computing / applied mathematics"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4539
Language:	**Person responsible for module:**

English	Programme coordinator
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.4941: Advanced 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

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. | **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 "Applied and mathematical stochastics"	

Admission requirements:	**Recommended previous knowledge:**
none	M.Mat.4541
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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:	Attendance time:
	28 h
The successful completion of modules of the cycle "Stochastic processes" enables	Self-study time:
students to learn and apply methods, concepts, theories and proof techniques in the	62 h
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

- 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: Programme coordinator
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: **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.	**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 "Stochastic methods in economathematics"	

Admission requirements: none	**Recommended previous knowledge:** M.Mat.4543
Language: English	**Person responsible for module:** Programme coordinator
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:	Recommended previous knowledge:
none	M.Mat.4544
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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:** Programme coordinator

Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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:	**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 • present a mathematical topic of current research interest in the area "Multivariate statistics" 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)	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:	Recommended previous knowledge:
none	M.Mat.4546
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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)	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 "Statistical foundations of data science"	

Admission requirements:	Recommended previous knowledge:
none	M.Mat.4547
Language:	**Person responsible for module:**
English	Programme coordinator
Course frequency:	**Duration:**
not specified	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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	9 C
Modul M.Phi.101: Ausgewählte Themen der Theoretischen Philosophie *English title: Selected Topics in Theoretical Philosophy*	4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	Präsenzzeit: 56 Stunden Selbststudium: 214 Stunden

Lehrveranstaltung: Vorlesung für Fortgeschrittene (= nicht Einführungskurs), Seminar oder Hauptseminar zu einem Thema der theoretischen Philosophie	2 SWS
Prüfung: Hausarbeit (max. 15 Seiten) oder mündliche Prüfung (ca. 30 Minuten) **Prüfungsvorleistungen:** Eine kleine Leistung (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

Lehrveranstaltung: Vorlesung für Fortgeschrittene (= nicht Einführungskurs), Seminar oder Hauptseminar zu einem Thema der theoretischen Philosophie	2 SWS
Prüfung: Eine kleine Leistung (max. 3 Seiten) (max. 3 Wörter), unbenotet **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.	2 C

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	keine

Sprache:	Modulverantwortliche[r]:
Deutsch	Prof. Dr. Christian Beyer
Angebotshäufigkeit:	**Dauer:**
jedes Semester	1-2 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	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.

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
Prüfung: Hausarbeit (max. 15 Seiten) oder mündliche Prüfung (ca. 30 Minuten) **Prüfungsvorleistungen:** Eine kleine Leistung (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

Lehrveranstaltung: Vorlesung für Fortgeschrittene (= nicht Einführungskurs), Seminar oder Hauptseminar zu einem Thema der praktischen Philosophie	2 SWS
Prüfung: Eine kleine Leistung (max. 3 Seiten), unbenotet **Prüfungsanforderungen:** 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.	2 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache:	**Modulverantwortliche[r]:**

Deutsch	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.

Georg-August-Universität Göttingen	9 C
Modul M.Phi.103: Ausgewählte Themen der Geschichte der Philosophie	4 SWS
English title: Selected Topics in History of Philosophy	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	Präsenzzeit: 56 Stunden Selbststudium: 214 Stunden
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.	

Lehrveranstaltung: Vorlesung für Fortgeschrittene (= nicht Einführungskurs), Seminar oder Hauptseminar zu einem Thema der Geschichte der Philosophie	2 SWS
Prüfung: Hausarbeit (max. 15 Seiten) oder mündliche Prüfung (ca. 30 Minuten) Prüfungsvorleistungen: Eine kleine Leistung (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

Lehrveranstaltung: Vorlesung für Fortgeschrittene (= nicht Einführungskurs), Seminar oder Hauptseminar zu einem Thema der Geschichte der Philosophie	2 SWS
Prüfung: Eine kleine Leistung (max. 3 Seiten) (max. 3 Seiten), unbenotet Prüfungsanforderungen: Fähigkeit, sich mit wichtigen philosophiegeschichtlichen Werken und Positionen auseinanderzusetzen, sie sachgemäß zu interpretieren sowie in ihren historischen und 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.	2 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache:	**Modulverantwortliche[r]:**

Deutsch	Prof. Dr. Bernd Ludwig
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.

Georg-August-Universität Göttingen	6 C
Modul M.WIWI-BWL.0001: Finanzwirtschaft	4 SWS
English title: Corporate Finance	

Lernziele/Kompetenzen:	Arbeitsaufwand:
Lernziele/Kompetenzen:	Präsenzzeit:
Mit dem erfolgreichen Abschluss des Moduls haben die Studierenden folgende Kompetenzen erworben:	56 Stunden
	Selbststudium:
	124 Stunden

Mit dem erfolgreichen Abschluss des Moduls haben die Studierenden folgende Kompetenzen erworben:

- sie sind in der Lage einen vertieften Überblick über die grundlegenden Fragen der betrieblichen Finanzwirtschaft und ihre Verbindungen zueinander zu geben,
- sie können die zentralen Methoden der Risikoanalyse und der Beurteilung von Investitionen verstehen, anwenden und kritisch reflektieren,
- sie verstehen die zentrale Theorien zur Marktbewertung riskanter Zahlungsströme und können diese kritisch reflektieren,
- sie verstehen die Hypothesen zur Informationseffizienz von Kapitalmärkten können und deren Konsequenzen für Investoren und Unternehmen beurteilen,
- sie verstehen verhaltenswissenschaftliche Aspekte in Finanzmärkten, deren ökonomische Fundierung und deren Auswirkungen auf Investitions- und Finanzierungsentscheidungen und sind in der Lage diese kritisch zu reflektieren,
- sie verstehen Theorien zur optimalen Kapitalstruktur und Dividendenpolitik von Unternehmen und können deren Verbindungen zu verschiedenen Marktfriktionen und Prinzipal-Agenten-Problemen aufzeigen,
- sie sind in der Lage Theorien zur optimalen Kapitalstruktur und Dividendenpolitik von Unternehmen hinsichtlich ihrer praktischen Implikationen und ihrer Fähigkeit zur Erklärung empirischer Phänomene zu beurteilen.

Lehrveranstaltung: Finanzwirtschaft (Vorlesung)	2 SWS

Inhalte:

1. Grundlegende Fragestellungen der betrieblichen Finanzwirtschaft
2. Investitionsentscheidungen unter Risiko: Risikoanalyse und subjektive Bewertung
3. Investitionsentscheidungen unter Risiko: Marktbewertung - Bewertungsmodelle (Capital Asset Pricing Model, Arbitrage Pricing Theory, Empirische Faktormodelle)
4. Investitionsentscheidungen unter Risiko: Marktbewertung - Implementierung
5. Finanzierungsinstrumente, effiziente Kapitalmärkte, Behavioral Finance und Finanzierungsentscheidungen
6. Kapitalstrukturentscheidungen
7. Dividenden und Ausschüttungspolitik

Teile des Materials der Vorlesungen werden durch Aufzeichnungen vermittelt, die von den Studierenden eigenständig durchzuarbeiten sind.

Lehrveranstaltung: Finanzwirtschaft (Übung)	2 SWS

Inhalte:

Im Rahmen der begleitenden Übung vertiefen und erweitern die Studierenden die in der Vorlesung erworbenen Kenntnisse und Fähigkeiten

Prüfung: Klausur (90 Minuten)	6 C

Prüfungsanforderungen:

- Darlegung eines übergreifenden Verständnisses grundlegender finanzwirtschaftlicher Fragestellungen.
- Nachweis der Kenntnis zentraler Methoden der Risikoanalyse und der Beurteilung von Investitionen unter Risiko sowie der Fähigkeit diese anzuwenden.
- Nachweis des Verständnisses zentraler Theorien zur Marktbewertung riskanter Zahlungsströme und der Fähigkeit zur kritischen Beurteilung dieser Theorien.
- Nachweis des Verständnisses der Hypothesen zur Informations-effizienz von Kapitalmärkten, verhaltenswissenschaftlicher Phänomene auf Kapitalmärkten sowie deren praktischer Implikationen für Investoren und Unternehmen.
- Fähigkeit zur Analyse von Fragen der optimalen Kapitalstruktur und der Dividendenpolitik von Unternehmen vor dem Hintergrund verschiedener Marktfriktionen und Prinzipal-Agenten-Problemen.

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	Grundkenntnisse aus finanzwirtschaftlichen Veranstaltungen im Bachelorstudium
Sprache:	**Modulverantwortliche[r]:**
Deutsch	Prof. Dr. Olaf Korn
Angebotshäufigkeit:	**Dauer:**
jedes Sommersemester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	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 International Risks 4. Managing Interest Rate Risk 5. Managing Credit Risk 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:	**Recommended previous knowledge:**
none	M.WIWI-BWL.0001 Finanzwirtschaft
Language:	**Person responsible for module:**
English	Prof. Dr. Olaf Korn
Course frequency:	**Duration:**
Every winter semester during the first half of the semester	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	2 - 3
Maximum number of students:	
not limited	

Georg-August-Universität Göttingen **Modul M.WIWI-BWL.0008: Derivate** *English title: Derivatives*	6 C 4 SWS

Lernziele/Kompetenzen: Nach dem erfolgreichen Abschluss des Moduls haben die Studierenden folgende Kompetenzen erworben: • sie besitzen vertiefte Kenntnisse über die verschiedenen Formen von Derivaten, insbesondere deren Ausgestaltung, Handel und Bedeutung, • sie können verschiedene Bewertungsansätze für Derivate (Duplikationsprinzip, Hedgingprinzip, Risikoneutrale Bewertung) verstehen und interpretieren, • sie verstehen die der Bewertung von Derivaten zugrundeliegende ökonomische Argumentation und sind in der Lage diese kritisch reflektierend zu bewerten, • sie verstehen die für die Bewertung und das Risikomanagement von Derivaten erforderlichen mathematisch-statistischen Verfahren und Kennzahlten und können diese anwenden, • sie sind in der Lage auch komplexe Derivate adäquat zu analysieren und selbständig computergestützt zu bewerten.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Derivate (Vorlesung) *Inhalte*: 1. Einführung 1.1. Begriffliche Grundlagen 1.2. Grundidee der Derivatebewertung 2. Forwards und Futures 2.1. Arbitragefreie Terminpreise 2.2. Forwards versus Futures 3. Optionen 3.1. Grundlagen 3.2. Verteilungsfreie Wertgrenzen 3.3. Arbitrageorientierte Bewertung 4. Risikomanagement von Derivatepositionen 4.1. Optionssensitivitäten 4.2. Risikosteuerung 4.3. Marktfriktionen und gleichgewichtsorientierte Bewertung	2 SWS

Die Erarbeitung des Vorlesungsstoffes erfolgt z.T. im Selbststudium auf Basis von Vorlesungsaufzeichnungen. In den Präsenzzeiten während der Vorlesungstermine kann daher verstärkt an Fallbeispielen und der konkreten Umsetzung der Konzepte durch die Studierenden gearbeitet werden.	
Lehrveranstaltung: Derivate (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: • Nachweis von Kenntnissen über die Ausgestaltungsformen von Derivaten, den Derivatehandel und die Bedeutung unterschiedlicher Produkte. • Nachweis von Kenntnissen über die verschiedenen Bewertungsansätze von Derivaten. • Nachweis über die Fähigkeit zur kritischen Analyse von Bewertungsmodellen und ihrer Annahmen. • Nachweis von Kenntnissen über die sich aus Bewertungsmodellen ergebenen Verfahren zum Risikomanagement von Derivaten und deren Anwendung. • Fähigkeit zur eigenständigen komplexer Derivatepositionen und zur Ermittlung von modellbasierten Werten.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Grundkenntnisse aus finanzwirtschaftlichen Veranstaltungen im Bachelorstudium
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Olaf Korn
Angebotshäufigkeit: jedes Wintersemester in der zweiten Hälfte der Vorlesungszeit	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** 1 - 3
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul M.WIWI-BWL.0023: Management Accounting** *English title: Management Accounting*	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 das Zusammenspiel und die Eignung der Implementierung von Elementen des Value Based Management und im Rahmen von Performance Measurement Systemen erworben.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Management Accounting (Vorlesung) *Inhalte*: Die Veranstaltung befasst sich mit wesentlichen Aspekten der Performancemessung unternehmerischer Aktivitäten mit dem Fokus auf einer wertorientierten Perspektive. Die Veranstaltung ist in vier 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. Danach erfolgt eine Einbettung dieser wertorientierten Ansätze in die Ausgestaltung von Performance Measurement Systemen.	2 SWS
Lehrveranstaltung: Management Accounting (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. Thematisch werden zunächst die Methoden der Unternehmensbewertung und deren Eignung für eine Wertorientiertes Steuerungssystem diskutiert. Darauf werden traditionelle Kennzahlenkonzepte vorgestellt und mögliche Nachteile aufgezeigt. Auf dieser Basis werden die methodischen Grundlagen von Wertorientierten Kennzahlen erörtert und deren Potentiale aufgezeigt. Zum Abschluss wird die Eignung der ganzheitlichen Implementierung von Value Based Management diskutiert.	2 SWS

Prüfung: Klausur (90 Minuten)	6 C

Prüfungsanforderungen: Nachweis von Kenntnissen der Konzepte, Dimensionen und Grenzen der Kapitalmarkt- und bilanzorientierte Performancemessung sowie des Value-Based Managements 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	

Georg-August-Universität Göttingen **Modul M.WIWI-BWL.0034: Logistik- und Supply Chain Management** *English title: Logistics and Supply Chain Management*	6 C 3 SWS

Lernziele/Kompetenzen:	Arbeitsaufwand:
Die Studierenden: • kennen die Teilbereiche und Funktionen der Logistik sowie des Supply Chain Managements und können diese klassifizieren, • kennen den Begriff „Standortplanung", können dessen Teilgebiete definieren und verschiedene OR-Modelle und Verfahren zur Standortbestimmung anwenden, • können das klassische Transportproblem erläutern und kennen dessen graphentheoretische Grundlagen, • kennen verschiedene Lösungsalgorithmen für das Transportproblem und können diese auch auf Sonderformen des klassischen Transportproblems anwenden, • kennen die Ausgestaltungsformen von Supply Chains und das SCOR-Modell, • können Produkt- und Prozessdesign voneinander abgrenzen, • kennen mögliche Formen der Vertragsgestaltung im Supply Chain Management, • kennen die verschiedenen Modelle der Bestellplanung und die Bestellregeln, • können statische Lagerhaltungsmodelle interpretieren und anwenden, • können dynamische Modelle voneinander abgrenzen und anwenden.	Präsenzzeit: 42 Stunden Selbststudium: 138 Stunden

Lehrveranstaltung: Logistik- und Supply Chain Management (Vorlesung) *Inhalte*: Inhaltlicher Schwerpunkt der Veranstaltung ist die Betrachtung der verschiedenen logistischen Strukturen und Probleme in und zwischen produzierenden Unternehmen. Dazu werden Quantitative Modelle vorgestellt und auf die Bereiche der Standortwahl, der Transportplanung, des Supply Chain Management und der Lagerhaltung angewendet.	2 SWS
Lehrveranstaltung: Logistik- und Supply Chain Management (Übung)	1 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Die Studierenden weisen in der Prüfung Kenntnisse in den folgenden Bereichen nach: • Grundlagen logistischer Problemstellungen • Standortplanung • Transportplanung • Supply Chain Management • Lagerhaltungsmodelle • Anwendung der vorgestellten OR-Modelle und Algorithmen auf die Problemstellungen der obigen Teilbereiche	6 C

Zugangsvoraussetzungen: keine	Empfohlene Vorkenntnisse: M.WIWI-BWL.0024 Unternehmensplanung
Sprache: Deutsch	Modulverantwortliche[r]: Prof. Dr. Jutta Geldermann

Angebotshäufigkeit:	Dauer:
jedes 4. Semester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	1 - 4
Maximale Studierendenzahl:	
nicht begrenzt	

Georg-August-Universität Göttingen **Module M.WIWI-BWL.0133: Banking Supervision**	6 C 2 WLH

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.	**Workload:** Attendance time: 28 h Self-study time: 152 h

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	2 WLH

Examination: Written examination (90 minutes)	6 C

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
- 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:	Recommended previous knowledge:
none	M.WIWI-BWL.0001 Finanzwirtschaft M.WIWI-BWL.0004 Financial Risk Management M.WIWI-BWL.0005 Rechnungslegung der Kreditinstitute
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:** 2 - 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:** Dr. Ossama Elshiewy
Course frequency: each summer semester	**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.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:** Module B.WIWI-OPH.0006: Statistics and module B.WIWI-OPH.0002: Mathematics

Language:	**Person responsible for module:**
English	Prof. Dr. Helmut Herwartz
Course frequency:	**Duration:**
each semester	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	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: As the outcome of this advanced course the students are able to	**Workload:** Attendance time:
- 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.	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:** Module 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:** B.WIWI-OPH.0006 Statistics and 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.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:** B.WIWI-OPH.0006 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: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**

twice	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 nominal factor prices, and (iv) on changes in the purchasing power of consumers, • evaluate and critically reflect the gains and losses of international trade, • evaluate the consequences of different trade policies like tariffs and subsidies, • understand, summarize, and critically assess recent approaches to explain international trade patterns that are observed today based on scientific publications.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: International Trade (Lecture) *Contents*: 1. **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. 2. **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. 3. **The neoclassical trade model in higher dimensions** 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. 4. **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	2 WLH

derivation of the empirical Gravity equation based on the monopolistic competition model.

5. **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.

6. **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.

7. **Project work**
   Recent empirical and theoretical contributions from the academic literature on international trade within the frame of student presentations.

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) **Examination prerequisites:** Presentation of a group work (approx. 20 min)	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:** Microeconomics
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	

Additional notes and regulations: The courses "M.WIWI-VWL.0003: Reale Außenwirtschaft" and "M.WIWI-VWL.0092: International Trade" are equal. Students can conclude only one of these courses.

Georg-August-Universität Göttingen **Module M.WIWI-VWL.0128: Deep Determinants of Growth and Development**	6 C 4 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 demography, education, and fundamental determinants of economic growth like culture, institutions, geography.	**Workload:** Attendance time: 56 h Self-study time: 124 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) (Bio-)Geography and Economic Development 2) Institutions 3) Government 4) Culture and Economic Development 5) The Deep Roots of Economic Development 6) Population and Economic Growth 7) Economic Growth in the Very Long Run	2 WLH
Course: Deep Determinants of Growth and Development (Tutorial) *Contents*: In the accompanying tutorials, students should discuss and solve problem sets to deepen and broaden their knowledge of the topics covered in the lectures.	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:** Dr. Katharina Werner
Course frequency: irregular	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** 1 - 4
Maximum number of students: not limited	

Georg-August-Universität Göttingen **Modul SK.FS.EN-FW-C1-1: Business English I - C1.1** *English title: Business English I - C1.1*	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 wirtschaftswissenschaftlicher Sprachhandlung auf Englisch vollzogen werden kann, wie z.B.: • Fähigkeit, mühelos an allen Unterhaltungen, Diskussionen und Verhandlungen mit allgemeinen und wirtschaftsbezogenen 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 wirtschaftsbezogene 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 wirtschaftswissenschaftlichen Wortschatzes; • Ausbau des operativen landeskundlichen und interkulturellen Wissens über die englischsprachigen Länder im beruflichen und wirtschaftlichen Kontext.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Business English I (Übung) *Inhalte*: • Management • Company Organisational Structures • Business Entities • Sectors of the Economy • Production and Products • Marketing • Advertising • Banking • Venture Capital • Market Structure • Competition In der Lehrveranstaltung werden die vier Sprachfertigkeiten 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: (1) Portfolio: 2 mündl. Arbeitsaufträge (ca. 15 Min. - mündl. Ausdruck 25 %) und 2-3 schriftl. Arbeitsaufträge (insg. max. 1000 Wörter - schriftl. Ausdruck 25 %); sowie (2) schriftl. Prüfung (insg. 90 Min. - Lese- und Hörverstehen jeweils 25 %)	6 C

Prüfungsvorleistungen:

regelmäßige und aktive Teilnahme

Prüfungsanforderungen:

Nachweis von sprachlichen Handlungskompetenzen in interkulturellen und
wirtschaftsbezogenen Kontexten unter Anwendung der vier Fertigkeiten Hören,
Sprechen, Lesen und Schreiben, d.h. Nachweis der Fähigkeit, rezeptiv wie produktiv
auf eine über das Niveau B2 des *Gemeinsamen europäischen Referenzrahmens
für Sprachen* hinausgehende Art mit für Wirtschaftswissenschaftlerinnen
und Wirtschaftswissenschaftler typischen mündlichen und schriftlichen
Kommunikationssituationen im Kontext von Studium, Forschung und Beruf umzugehen.

Zugangsvoraussetzungen: Modul Mittelstufe II oder Einstufungstest mit abgeschlossenem Niveau B2.2 des GER	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Ashley Chandler
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Georg-August-Universität Göttingen **Modul SK.FS.EN-FW-C1-2: Business English II - C1.2** *English title: Business English II - C1.2*	6 C 4 SWS

Lernziele/Kompetenzen: Weiterentwicklung vorhandener diskursiver Fertigkeiten und Kompetenzen bis zum Niveau C1 des *Gemeinsamen europäischen Referenzrahmens für Sprachen*, mit Hilfe derer auch sehr komplexe berufliche und wirtschaftswissenschaftliche Sprachhandlungen auf Englisch vollzogen werden können, wie z.B.: • Weiterentwicklung der Fähigkeit, mühelos an allen Unterhaltungen, Diskussionen und Verhandlungen mit allgemeinen und wirtschaftsbezogenen Inhalten teilzunehmen, solche mündlichen Kommunikationssituationen zu leiten bzw. aktiv mitzugestalten sowie eigene Beiträge inhaltlich komplex und sprachlich angemessen zu formulieren; • Weiterentwicklung der Fähigkeit, auch umfangreichere wirtschaftsbezogene Publikationen zu allen Themen zu verstehen und unter Anwendung spezifischer Sprachstrukturen und -konventionen sprachlich und stilistisch sicher auf einem hohen Niveau selbst zu verfassen; • ergänzender Erwerb spezifischer sprachlicher und stilistischer Strukturen der englischen Sprache sowie Weiterentwicklung eines differenzierten wirtschaftswissenschaftlichen Wortschatzes; • Ausbau des operativen landeskundlichen und interkulturellen Wissens über die englischsprachigen Länder im beruflichen und wirtschaftlichen Kontext.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Business English II (Übung) *Inhalte*: • Stock Exchanges • Bonds and Derivatives • Takeovers, Mergers and Buyouts • The Role of Government • Taxation • Central Banking • Economic Growth • The Business Cycle • Keynesianism and Monetarism • Efficiency • Employment • Exchange Rates • International Trade In der Lehrveranstaltung werden die vier Sprachfertigkeiten 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: (1) Portfolio: 2 mündl. Arbeitsaufträge (ca. 15 Min. - mündl. Ausdruck 25 %) und 2-3 schriftl. Arbeitsaufträge (insg. max. 1000 Wörter - schriftl. Ausdruck 25	6 C

%); sowie (2) schriftl. Prüfung (insg. 90 Min. - Lese- und Hörverstehen jeweils 25 %)

Prüfungsvorleistungen:

regelmäßige und aktive Teilnahme

Prüfungsanforderungen:

Nachweis von sprachlichen Handlungskompetenzen in interkulturellen und wirtschaftsbezogenen Kontexten unter Anwendung der vier Fertigkeiten Hören, Sprechen, Lesen und Schreiben, d.h. Nachweis der Fähigkeit, rezeptiv wie produktiv auf eine dem Niveau C1 des *Gemeinsamen europäischen Referenzrahmens für Sprachen* angemessene Art mit für Wirtschaftswissenschaftlerinnen und Wirtschaftswissenschaftler typischen mündlichen und schriftlichen Kommunikationssituationen im Kontext von Studium, Forschung und Beruf umzugehen.

Zugangsvoraussetzungen: Modul Business English I	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Ashley Chandler
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

Fakultät für Agrarwissenschaften:

Nach Beschluss des Fakultätsrats der Fakultät für Agrarwissenschaften vom 12.12.2019 hat das Präsidium der Georg-August-Universität am 21.01.2020 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).

Die Neufassung des Modulverzeichnisses tritt nach seiner Bekanntmachung in den Amtlichen Mitteilungen II zum 01.04.2020 in Kraft.

Fakultät für Agrarwissenschaften:

Nach Beschluss des Fakultätsrats der Fakultät für Agrarwissenschaften vom 12.12.2019 hat das Präsidium der Georg-August-Universität am 21.01.2020 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).

Modulverzeichnis

zu der Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang "Agrarwissenschaften" (Amtliche Mitteilungen I Nr. 7/2012 S. 116, zuletzt geändert durch Amtliche Mitteilungen I Nr. 5/2020 S. 94)

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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. Nach Anmeldung für das 5. Modul ist die Anmeldung für ein weiteres der nachfolgenden Module erst zulässig, sofern eines der zunächst belegten 5 Module endgültig nicht bestanden wurde oder als nicht bestanden gilt.

cc. Block C

Es müssen das Modul M.Agr.0077 sowie eines der Module B.WiWi-VWL.0007 und M.Agr.0012 im Umfang von insgesamt 12 C (Bereich Schlüsselkompetenzen) erfolgreich absolviert werden.

b. Schwerpunkt "Nutzpflanzenwissenschaften"

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. Nach Anmeldung für das 5. Modul ist die Anmeldung für ein weiteres der nachfolgenden Module erst zulässig, sofern eines der zunächst belegten 5 Module endgültig nicht bestanden wurde oder als nicht bestanden gilt.

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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 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 30 C erfolgreich absolviert werden. Nach Anmeldung für das 5. Modul ist die Anmeldung für ein weiteres der nachfolgenden Module erst zulässig, sofern eines der zunächst belegten 5 Module endgültig nicht bestanden wurde oder als nicht bestanden gilt.

Inhaltsverzeichnis

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. Nach Anmeldung für das 5. Modul ist die Anmeldung für ein weiteres der nachfolgenden Module erst zulässig, sofern eines der zunächst belegten 5 Module endgültig nicht bestanden wurde oder als nicht bestanden gilt.

Inhaltsverzeichnis

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. Nach Anmeldung für das 5. Modul ist die Anmeldung für ein weiteres der nachfolgenden Module erst zulässig, sofern eines der zunächst belegten 5 Module endgültig nicht bestanden wurde oder als nicht bestanden gilt.

cc. Block C

Ferner müssen die 2 folgenden Wahlpflichtmodule (Bereich Schlüsselkompetenzen) im Umfang von insgesamt 12 C erfolgreich absolviert werden:

2. 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. Nach Anmeldung für das 5. Modul ist die Anmeldung für ein weiteres Modul erst zulässig, sofern eines der zunächst belegten 5 Module endgültig nicht bestanden wurde oder als nicht bestanden gilt.

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"

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, 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: Written exam (45 minutes; 50%) and protocols (max. 5 pages; 50%) **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 exam will be bi-lingual (German+English). 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	6 C
Module M.Agr.0003: Agribusiness Sugar Beet- an advanced education for graduate students and junior employees of the sugar supply chain (English)	

Learning outcome, core skills:	**Workload:**
• 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	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:** apl. Prof. Anne-Katrin Mahlein
Course frequency: each summer semester	**Duration:** 1 Week

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*: 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]:** Prof. Dr. Gabriele Hörstgen-Schwark
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. Stefan Vidal
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	6 C (Anteil SK: 6 C)
Modul M.Agr.0012: Empirische Methoden: Marktforschung und Verbraucherverhalten	4 SWS
English title: Empirical methods: market research and consumer behavior	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Empirische Methoden: Marktforschung und Verbraucherverhalten (Seminar)	4 SWS
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.	
Prüfung: Klausur (60 Minuten, Gewichtung: 50%) und Hausarbeit (max. 15 Seiten, Gewichtung: 50%) **Prüfungsanforderungen:** Das Modul besteht aus einem theoretischen Teil und einem konkreten Marktforschungsprojekt zu einem aktuellen Thema. Prüfungsanfoderungen sind: dizidierte Kenntnisse der Theorien des Käuferverhaltens, Exkurs: Theorien des landwirtschaftlichen Managementverhaltens, von univariaten Verfahren, bivariaten Verfahren, ausgewählten multivariaten Verfahren (Faktorenanalyse, Clusteranalyse, Regressionsanalyse, Kausalanalyse, Diskriminanzanalyse, Multinomiale Regressionsanalyse)	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 **Modul M.Agr.0013: Epidemiology of International and Tropical Animal Infectious Diseases** *English title: Epidemiology of international and tropical animal infectious diseases*	6 C 4 SWS
Lernziele/Kompetenzen: Auf der Basis eines zeitgemäßen wissenschaftlichen und praktischen Kenntnisstandes können die Studierenden moderne und effektive Tierhygiene und Agrarkonzepte beurteilen, entwickeln und in komplexe Qualitätsmanagementprogramme integrieren. Die Absolventen sind fähig ihr Wissen in multidisziplinäre berufsbezogene Arbeitsbereiche zu implementieren und zu kommunizieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Lehrveranstaltung: Epidemiology of International and Tropical Animal Infectious Diseases (Vorlesung) *Inhalte*: Infektionserkrankungen spielen in der internationalen Tiergesundheitsüberwachung eine bedeutende Rolle. Nationale Gesundheits- und Veterinärbehörden, sowie internationale Organisationen (WHO, FAO) sind sehr stark in der Seuchenüberwachung engagiert und mit der Etablierung von Gesundheits- und Hygiene-Monitoring-Programmen beschäftigt. Diese Aufgaben werden sich in Zukunft auf Grund einer weiteren Globalisierung des internationalen Marktes noch steigern und es werden gut ausgebildete Experten für die weltweite Zusammenarbeit in diesem multidisziplinären Feld benötigt. Dieses Modul gibt einen Überblick über aktuelle Epidemien im Zusammenhang mit der Vermittlung eines spezialisierten Verständnisses über Infektionskrankheiten und Hygieneprogramme in den subtropischen und tropischen Ländern. Charakteristika von biologisch relevanten Infektionserregern wie Parasiten, Pilzen und Bakterien, deren Toxine sowie Viren und Prionen werden ausführlich dargestellt. Einige der Keime, die in diesem Modul behandelt werden, sind Ursache für schwere zoonotische Erkrankungen mit letaler Gefahr für den Menschen. Immunologische Abwehrmechanismen wilder und domestizierter Tiere gegen Pathogene werden zusammen mit modernen Strategien der aktiven und passiven Immunisierung diskutiert. Gegenwärtig erhältliche diagnostische Methoden und neue biotechnologische Ansätze in zukünftigen Testsystemen und in der Impfstoffentwicklung werden demonstriert. Die Adaptierung von praxisnahen Gesundheits- und Hygienemaßnahmen und von standardisierten Qualitätsmanagement-Regularien an die verschiedenen Tierproduktionssysteme (Wiederkäuer, Schweine, Geflügel) wie auch an die nachgelagerten Produktionsprozesse wird zusammen mit den entsprechenden Managementmethoden erklärt. Der Blick wird stark auf ökologische Belastungen (Wasser, Boden, Lufthygiene), Epizootiologie und moderne Werkzeuge in der epizootologischen Forschung gerichtet sein. Die Lehrinhalte werden die Biologie und die Ausrottung von Vektoren (Insekten, Zecken) aufzeigen, die Tierpathogene und zoonotische Erkrankungen übertragen, sowie biologische und chemische Methoden zur Vektorkontrolle. In einem Laborkurs werden in diesem Modul auch die bereits gut etablierten Techniken der mikrobiologischen und parasitologischen Diagnostik vermittelt. Die Studierenden werden praktische Übungen mit klassischen Methoden sowie mit modernen biochemischen, immunologischen, biotechnologischen und molekularbiologischen	4 SWS

Techniken zur Analyse von Infektionserregern, Toxinen und gesundheitsschädlichen Substanzen durchführen. Gewebskulturverfahren für die Entwicklung von Impfstoffen oder Antikörper werden zusätzlich angewendet.	
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Überblick über die Biologie von pathogenen Mikroorganismen, Infektionskrankheiten; Immunologie von Nutztieren; Schutzimpfungen; Diagnose; Vektorausrottung; internationale freiwillige und staatlich verpflichtende Hygieneprogramme; Analyse der Hygiene in landwirtschaftlichen Tierproduktionssystemen.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** N. N.
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0014: Ernährungsphysiologie	4 SWS
English title: Nutrition Physiology	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Ernährungsphysiologie (Vorlesung, Übung)	4 SWS
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.	

Prüfung: Mündlich (ca. 30 Minuten)	6 C
Prüfungsanforderungen: Spezifische und umfassende Kentnisse 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).	

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	Kenntnisse aus den in den Modulen "Nutztierwissenschaften I" und "Tierernährung" behandelten Themenbereichen werden erwartet.

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 Spezialtechniken 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]:** Prof. Dr. Timothy Mathes Beissinger
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 Agrarland-schaft** *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. Detailliert 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.0024: International and Tropical Food Microbiology and Hygiene** *English title: International and tropical food microbiology and hygiene*	6 C 4 SWS

Lernziele/Kompetenzen: Auf der Basis eines wissenschaftlich zeitgemäßen Kenntnisstandes können die Studierenden moderne und effektive Lebensmittelhygiene-Konzepte bewerten und in komplexe Qualitätsmanagementprogramme integrieren. Die Absolventen sind fähig, ihr Fachwissen in multidisziplinären Arbeitsbereichen der Nahrungsmittelmikrobiologie und -hygiene anzuwenden.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: International and Tropical Food Microbiology and Hygiene (Vorlesung) *Inhalte*: Infektiöse Pathogene und Toxine sind weltweit die Verursacher der meisten Lebensmittelkontaminationen mit Einfluss auf die menschliche Gesundheit. Globale Märkte erfordern ein internationales Überwachungssystem sowie standardisierte Lebensmittelhygiene-Regularien. Dieses Modul gibt einen allgemeinen Überblick über aktuelle international relevante Lebensmittel-bedingte Zoonosen, sowie über Lebensmittelhygieneprogramme. Ein spezieller Aspekt ist die Analyse der Voraussetzungen für solche Programme in den Subtropen und Tropen. Ausführlich wird die Biologie der Infektionserreger erklärt (Parasiten, Pilze, Hefen, Bakterien, Viren, Prionen und Toxinen), die für die Kontamination und Intoxikation von menschlichen Nahrungsmitteln tierischer Herkunft verantwortlich sind. Einige dieser Keime sind die Ursache für schwere Erkrankungen mit einem letalen Potenzial für Menschen oder Menschen bestimmter Altersgruppen. Die Widerstandsfähigkeit spezieller Mikroorganismen in den Matrices Fleisch, Milch und Eiern und in den dazugehörigen Produkten wird anhand des kompletten Produktionsprozesses „from stable to table" erläutert. Ebenso wird der Verderb von Nahrungsmitteln durch Mikroorganismen diskutiert. Gegenwärtig verfügbare diagnostische Methoden für die Entdeckung von kontaminierten oder verdorbenen Nahrungsmitteln und neue biotechnologische Ansätze in Bezug auf zukünftige Test-Formate werden analysiert. Die Adaptierung von praxisnahen Hygieneregeln und standardisierten Qualitätsmanagement-Systemen an die verschiedenen Tierproduktionssysteme (Wiederkäuer, Schweine, Geflügel) bzw. die nachgelagerten Produktionsprozesse werden erklärt. Diese beinhalten Lebensmittelkonservierung, Keimabreicherung und Keimabtötung (Reinigung, Desinfizektion, Autoklavierung, Sterilisation). Neben den negativen mikrobiellen Effekten auf die Nahrungsmittelqualität, werden auch positive Einflüsse, vor allem von Bakterien und Pilzen, auf die Lebensmittelproduktion präsentiert. Biotechnologische Aspekte von genetisch veränderten Nahrungsmittelzusätzen oder gezielt veränderten Keimen sollen diskutiert werden. Dieses Modul wird außerdem in einem praktischen Laborkurs über Lebensmittel-Mikrobiologie gut etablierte Techniken für die mikrobiologische und parasitologische	4 SWS

Diagnostik in verschiedenen Lebensmitteln vermitteln. Die Studierenden werden sowohl klassische Methoden, als auch moderne biochemische, immunologische, biotechnologische und molekularbiologische Techniken zur Detektion von infektiösen Keimen, Toxinen und schädlichen Substanzen, die in Lebensmitteln enthalten sein können, praktisch üben.

Prüfung: Mündlich (ca. 25 Minuten) **Prüfungsanforderungen:** Grundlagenkenntnisse der Biologie und Pathogenese von Lebensmittel-bedingten Mikroorganismen, positiver Effekte von Mikroorganismen in der Lebensmittel-Technologie und -verarbeitung, Diagnostik, internationaler öffentlicher Hygieneüberwachungsprogramme, hygienischer Analyse der Lebensmittelproduktion, Konservierung von Lebensmitteln und Abreicherung von Mikroorganismen und Desinfektion.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** N. N.
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen **Modul M.Agr.0025: Kartoffelproduktion** *English title: Potato production*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studenten 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	6 C
Modul M.Agr.0027: Kompaktmodul - Das Geflügel	6 SWS
English title: Compact course - poultry	

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:* jedes Sommersemester	
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. Martina Gerken
Angebotshäufigkeit: Sommersemster 2015, dann alle zwei jahre	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 48	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0028: Kompaktmodul - Das Milchrind *English title: Compact Course - Dairy cow*	

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. Henner Simianer
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0029: Kompaktmodul - Das Schwein	6 SWS
English title: Compact course - pig	

Lernziele/Kompetenzen:	Arbeitsaufwand:
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.	Präsenzzeit: 140 Stunden Selbststudium: 40 Stunden

Lehrveranstaltung: Kompaktmodul - Das Schwein (Vorlesung, Exkursion)	6 SWS
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	
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	6 C
Modul M.Agr.0031: Leistungsphysiologie	4 SWS
English title: Performance Physiology	

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)	4 SWS
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.	

Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:**	6 C
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.	

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	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	6 C (Anteil SK: 6 C)
Modul M.Agr.0034: Methodisches Arbeiten: Interdisziplinäre Projekt-arbeit *English title: Methodological work: interdisciplinary research project*	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 Modul, 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 eigenen | 6 C |

Ergebnisse unter Berücksichtigung der wissenschaftlichen Fachliteratur im Fokus der Prüfungsanforderungen (70% der Modulnote).

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Teja Tscharntke
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen	6 C (Anteil SK: 6 C)
Modul M.Agr.0035: Methodisches Arbeiten: Interdisziplinäres Seminar *English title: Methods of scientific presentation: An interdisciplinary course*	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	6 C (Anteil SK: 6 C)
Modul M.Agr.0036: Methodisches Arbeiten: Versuchsplanung und -auswertung *English title: Methods of scientific presentation: Experiment planning and evaluation*	4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Methodisches Arbeiten: Versuchsplanung und -auswertung (Vorlesung, Übung)	4 SWS
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.	
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundkenntnisse der - Methoden zur Planung von Versuchen - Statischen Methoden zur Auswertung von Versuchen	6 C

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	keine
Sprache:	**Modulverantwortliche[r]:**

Deutsch	Dr. sc. agr. Ahmad Reza Sharifi
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 80	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0039: Molecular Techniques in Phytopathology *English title: Molecular Techniques in Phytopathology*	4 SWS

Lernziele/Kompetenzen:	Arbeitsaufwand:
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.	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.0041: Molekularbiologische Methoden in der Pflanzen-züchtung** *English title: Molecularbiologcal methods in plant breeding*	6 C

Lernziele/Kompetenzen: In dem Modul lernen die Studierenden molekularbiologische Techniken zu beurteilen und einzuschätzen, an welchen Stellen molekularbiologische Methoden bei der Problemlösung in der Pflanzenzüchtung eingesetzt werden können aber auch welchen Grenzen die Methoden unterliegen. So lernen sie wissenschaftlich fundierte Entscheidungen zu fällen und dabei ökonomische Sachzwänge zu berücksichtigen.	**Arbeitsaufwand:** Präsenzzeit: 80 Stunden Selbststudium: 100 Stunden

Lehrveranstaltung: Molekularbiologische Methoden in der Pflanzenzüchtung (Blockveranstaltung, Praktikum, Vorlesung) *Inhalte*: Im Praktikum werden moderne molekularbiologische Methoden vermittelt. Hierzu werden am Beispiel des Raps drei Themenkreise in praktischen Versuchen bearbeitet: die RFLP-Analyse von Gesamt-DNA, die „shot gun" Klonierung von DNA in E. coli und die RAPD-Analyse. Die dabei vermittelten Techniken umfassen Gesamt-DNA und Plasmidisolation, DNA-Verdau mit Restriktionsendonukleasen, DNA-Gelelektrophorese und Southern-Blotting, DNA-Hybridisierung, DNA-Ligation, Transformation von E. coli und PCR. In einer begleitenden Vorlesung werden die theoretischen Grundlagen zu den drei genannten Themenkreisen und den vermittelten Techniken durchgenommen.	
Prüfung: Mündlich (ca. 25 Minuten) **Prüfungsvorleistungen:** Regelmäßige Teilnahme am Praktikum und Blockveranstaltung, Abgabe eines Protokolls über die im Modul durchgeführten Versuche **Prüfungsanforderungen:** Theoretische Grundlagen der Molekulargenetik. Kenntnisse zum praktischen Einsatz von Markern und zur Klonierung von DNA.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** PD Dr. Wolfgang Ecke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 6	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0044: Molekulare Phytopathologie, Diagnostik und Biotechnologie im Pflanzenschutz	4 SWS
English title: Molecular phytopathology, diagnostics and biotechnology in plant protection	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Kompetenzen: Studierende gewinnen Fachkenntnisse über molekulardiagnostische Verfahren, entwickeln Verständnis für die molekulare Arbeitsweise in der Phytopathologie und werden mit der Bedeutung von toxisch wirkenden Produkten von Krankheitserregern vertraut. Sie werden die Grundlagen und Einsatzmöglichkeiten pflanzlicher Biotechnologie und ihren rechtlichen Rahmen verstehen.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden
Schlüsselkompetenzen: Arbeit mit Primärliteratur, Präsentation und kritische Diskussion von publizierten Daten, Entwicklung des Bewusstseins für rechtliche Aspekte biotechnologischer Anwendungen	

Lehrveranstaltung: Molekulare Phytopathologie, Diagnostik und Biotechnologie im Pflanzenschutz (Vorlesung)	4 SWS
Inhalte:	
In der Vorlesung werden Prinzipien und Anwendungen molekulardiagnostischer Verfahren systematisch behandelt. Die molekulare Denk- und Arbeitsweise in der Phytopathologie wird an ausgesuchten Beispielen von Toxinen vermittelt, die von Krankheitserregern gebildet werden. Die Grundlagen und der Einsatz von struktureller und funktionaler Genomforschung und molekularen Hochdurchsatztechnologien in der Phytopathologie wird erläutert. Schließlich werden Strategien und Anwendungsmöglicheiten für biotechnologische Verfahren im Pflanzenschutz erklärt. Der rechtliche Rahmen für die Verwendung gentechnisch veränderter Organismen (GVO) in der Forschung und die Freisetzung und das Inverkehrbringen von GVOs in der Pflanzenproduktion und Lebensmittelherstellung wird erläutert, wobei auch dem Widerspruch zwischen dem Stand des Wissens und der Wahrnehmung der Gentechnologie in den Massenmedien und der Politik Aufmerksamkeit gewidmet wird. Im Seminar werden ausgewählte Themen aus diesen Bereichen von den Teilnehmern ausgearbeitet und diskutiert.	

Prüfung: Mündliche Prüfung (Gewicht:: 50%, Dauer: ca. 25 Minuten) und Präsentation, Referat oder Korreferat (Gewicht: 50%, Dauer: ca. 20 Minuten) Prüfungsanforderungen:	6 C
Grundlagen, Prinzipien und Einsatzmöglichkeiten von molekulardiagnostischen Verfahren, wirtsspezifischer und nichtwirtsspezifischer Toxine, experimenteller Strategien zur Bestimmung der Rolle eines Sekundärmetaboliten in der Pathogenese, Wirkmechanismen von Toxinen, natürlichen und biotechnologisch herbeigeführter Resistenz. Basiswissen über den rechtlichen Rahmen für den Einsatz von gentechnisch veränderten Organismen in der Forschung, in Pflanzenproduktion und Lebensmittelherstellung.	

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**

keine	keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Petr Karlovsky
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 36	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0045: Mycology	4 SWS
English title: Mycology	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Mycology (Praktikum, Vorlesung)	4 SWS
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.	
Prüfung: Mündlich (ca. 20 Minuten) **Prüfungsvorleistungen:** Gruppenprotokoll und Ergebnispräsentation **Prüfungsanforderungen:** Grundlagenkenntnisse in Pilztaxonomie, Lebenszyklen, ökologischer Ansprüche, diagnostischer Merkmale, Krankheiten und pflanzenassoziierte 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	6 C
Modul M.Agr.0047: Naturschutz interfakultativ I *English title: Nature conservation I (interfaculty lectures)*	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 1 (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 ersten Block geht es um die Wissenschaftlichen Grundlagen des Naturschutzes (Zentrum für Naturschutz), die Grundlagen der Agrarökologie (Abt. Agrarökologie) und die Landschaftsökologische Analyse und Bewertung (Geographisches Institut).	
Prüfung: Klausur (60 Minuten) **Prüfungsanforderungen:** Erarbeitung des in den Vorlesungen angebotenen breiten Basiswissens im Bereich Naturschutz. Vorbereitung und Nachbereitung der Vorlesung für die abschließende Klausur	6 C

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

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0048: Naturschutz interfakultativ II	4 SWS
English title: Nature Conservation II (interfaculty lectures)	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	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)	6 C
Prüfungsanforderungen:	
Erarbeitung des in den Vorlesungen angebotenen breiten Basiswissens im Bereich Naturschutz. Vorbereitung Nachbereitung der Vorlesungen für die abschließende Klausur	

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

Georg-August-Universität Göttingen **Modul M.Agr.0051: Nutztiere und Landschaft** *English title: Farm animals and landscape*	6 C 4 SWS

Lernziele/Kompetenzen:	Arbeitsaufwand:
Die Studierenden kennen Grundlagen sowie Konzepte der Landschaftspflege durch Weidetiere. Sie verstehen die Bedeutung der Weidewirtschaft für das Landschaftsbild. Mit den erworbenen Kenntnissen können sie die Wechselbeziehungen zwischen Weidetieren und Weidemanagement analysieren. Auf der Basis der vermittelten Grundlagen können sie ggf. Konzepte für die Landschaftspflege durch Weidetiere bewerten und selbständig weitergehend erarbeiten. Sie erlernen Grundlagen für die Entwicklung forschungs- bzw. anwendungsorientierter Beweidungsprojekte.	Präsenzzeit: 58 Stunden Selbststudium: 122 Stunden

Lehrveranstaltung: Nutztiere und Landschaft (Vorlesung, Exkursion, Seminar) *Inhalte*: Entwicklung der europäischen Landschaften unter dem Einfluss von Weidetieren, Weidewirtschaft und Ressourcennutzung im Landschaftsmaßstab, Grundlagen der Futtererzeugung, Tierarten für die Weidewirtschaft, Wechselwirkungen zwischen Weidetier, Pflanzen und Landschaft, Weidemanagement.	4 SWS
Prüfung: Klausur (Gewicht: 50%, Dauer: 45 Minuten) und Projektarbeit (Gewicht: 50%, Umfang: max. 2 Seiten Thesenpapier) **Prüfungsanforderungen:** Einführende Kenntnisse der Weidewirtschaft, Futtererzeugung, von Wechselwirkungen Weidetier und Vegetation, Weidemanagement, Einfluss der Tierarten und der Interpretation wissenschaftlicher Ergebnisse.	6 C

Zugangsvoraussetzungen: keine	Empfohlene Vorkenntnisse: keine
Sprache: Deutsch	Modulverantwortliche[r]: Prof. Dr. Martina Gerken
Angebotshäufigkeit: jedes Wintersemester	Dauer: 1 Semester
Wiederholbarkeit: zweimalig	Empfohlenes Fachsemester:
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0052: Ökologie und Naturschutz	7 SWS
English title: Ecology and nature conservation	

Lernziele/Kompetenzen:	Arbeitsaufwand:
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.	Präsenzzeit: 93 Stunden Selbststudium: 87 Stunden

Lehrveranstaltung: Bewertung und Pflege von Lebensräumen (Vorlesung, Übung)	5 SWS
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	

Prüfung: Präsentation, Referat oder Korreferat (Gewicht: 60%, Dauer: ca. 20 Minuten) und Hausarbeit (Gewicht: 40%, Umfang: max. 25 Seiten) **Prüfungsanforderungen:**	3 C
Grundlegende Kenntnisse im Bereich der Bewertung und Pflage von Lebensräumen, ausführliches Protokoll (Hausarbeit) und Referat zu einem ausgewählten Lebensraum	

Lehrveranstaltung: Landwirtschaft und Naturschutz (Seminar)	2 SWS
Inhalte: Interdisziplinäre Perspektive auf Fragen der umweltfreundlichen Agrarproduktion, naturschutzgerechten Landschaftsplanung und des Ressourcenmanagements in multifunktionalen Agrarlandschaften.	

Prüfung: Präsentation, Referat oder Korreferat (ca. 20 Minuten) **Prüfungsanforderungen:**	3 C
Ausführliche Kenntnisse zur interdisziplinären Sichtweise auf Probleme im Spannungsfeld von Landwirtschaft und Naturschutz; Vorbereitung der Seminarsitzung, Erarbeitung eines Themas für ein Referat	

Zugangsvoraussetzungen: keine	Empfohlene Vorkenntnisse: keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Teja Tscharntke
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**

| **Maximale Studierendenzahl:** | |
| 25 | |

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. Ludwig Theuvsen
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.0054: Personalmanagement in der Agrar- und Ernährungswirtschaft** *English title: Human resource management in agribusiness*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden lernen, praktische Problemstellungen im personalwirtschaftlichen Bereich, denen sie in der betrieblichen Praxis begegnen werden, zu identifizieren und unter Rückgriff auf das erlernte theoretische Rüstzeug und die in den Übungen trainierten diagnostischen Fähigkeiten zu lösen. Neben der Entwicklung instrumenteller Kompetenzen, etwa im Bereich der Gestaltung betrieblicher Anreizsysteme, steht die Verbesserung sozialer Kompetenzen in Führungssituationen im Vordergrund.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Personalmanagement in der Agrar- und Ernährungswirtschaft (Vorlesung, Seminar) *Inhalte*: Das Modul führt im Vorlesungteil in Grundzüge des Personalmanagements in der Agrar- und Ernährungswirtschaft ein. In der Vorlesung werden vor allem Grundzüge des deutschen Arbeitsrechts sowie Kenntnisse der Personalführung und -motivation vermittelt. Neben Theorien der Personalführung und -motivation werden auch Gestaltungsaspekte betrieblicher Anreizsysteme gelehrt. Im Seminarteil werden die Inhalte der Vorlesung vertieft und angewandt sowie durch einige ausgewählte Aspekte wie Employer Branding und Recruiting ergänzt. Als Lernform wird hier das Referat gewählt, das in Kleingruppen erarbeitet aber auch vorgetragen wird.	4 SWS
Prüfung: Klausur (60 Minuten, 75%) und Präsentation (ca. 20 Minuten, 25%) **Prüfungsanforderungen:** Grundzüge des Arbeitsrechts, der Inhalts- und Prozesstheorien der Motivation, von Führungstheorien und -verhalten sowie finanzieller und nicht finanzieller Anreizsysteme.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. agr. sc. Verena Otter
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 100	

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 Probleme 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	6 C
Module M.Agr.0057: Plant Virology	6 WLH

Learning outcome, core skills:	**Workload:**
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.	Attendance time: 80 h Self-study time: 100 h

Course: Plant Virology (Internship, Lecture)	6 WLH
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	

Examination: Written exam (45 minutes, weighing 50%) and term paper (max. 20 pages, weighing 50%)	6 C
Examination prerequisites: Regular participation at the practical course following the lecture **Examination requirements:** Understanding of the imparted detection methods and knowledge about virus biology.	

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.0059: Präzise bedarfsorientierte Prozesssteuerung in der Nutztierhaltung (PLF)** *English title: Precision livestock farming*	6 C 4 SWS

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.	**Arbeitsaufwand:** Präsenzzeit: 64 Stunden Selbststudium: 116 Stunden

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.	4 SWS
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)	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse aus den im Modul "Grundlagen der Agrartechnik" behandelten Themenbereichen werden erwartet.
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Imke Traulsen
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:	Dauer:
jedes Wintersemester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	
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 Agrarland-schaft** *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. 12 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. Teja Tscharntke
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0064: Qualitätsbildung in pflanzlichen Produkten *English title: Quality development in plant products*	4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Die Studenten werden befähigt, bisher erworbenes Wissen in einen multidisziplinären komplexen Zusammenhang zu stellen. Sie erlernen, vermittelte Informationen und Erkenntnisse in einen gesamtgesellschaftlichen Kontext einzuordnen. Darüberhinaus wird durch die gemeinsame Bearbeitung von Referatsthemen die Teamfähigkeit geschult. Außerdem werden die Studenten weiter befähigt, Wissen zu präsentieren und einen wissenschaftlichen Meinungsaustausch zu führen.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Qualitätsbildung in pflanzlichen Produkten (Vorlesung, Exkursion, Übung, Seminar) *Inhalte*: Betrachtung der gesamten Wertschöpfungskette im Hinblick auf die Qualitätsbildung und -erhaltung bei pflanzlichen Produkten, einschließlich der gesellschaftspolitischen Rahmenbedingungen: Züchtung, Anbau, Ernte und Nacherntebereich, Verarbeitung, Ernährungsphysiologie, Verbraucherverhalten, Qualitätsmanagement und Qualitätssicherung in der Lebensmittelkette (EU-Gesetzgebung), Exkursion	4 SWS
Prüfung: Hausarbeit (Gewicht: 60%, Umfang: max. 20 Seiten) und Präsentation, Referat oder Korreferat (Gewicht: 40%, Dauer: ca. 20 Minuten) **Prüfungsanforderungen:** Weiterführende Kenntnisse und Fertigkeiten in der • Präsentation (Referat) zu einem Thema, das aus den Lehrinhalten gewählt wird • Anfertigung einer Hausarbeit zum gleichen Bereich unter Verwendung englischsprachiger Literatur	6 C

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

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; Futter-qualitätsverbesserung durch spezielle Behandlungsverfahren, Futter-mittelhygienevorschriften; 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:	Empfohlenes Fachsemester:
zweimalig	
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. Henner Simianer
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

90	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0069: Reproduktionsbiotechnologie *English title: Reproduction biotechnology*	5 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen detaillierte Kenntnisse über reproduktionsbiotechnologische Methoden und Verfahren, die in der modernen Tierzucht und beim Menschen angewendet werden. Der Einsatz, die Chancen und Risiken dieser Techniken werden speziesspezifisch diskutiert und gewertet. Den Studierenden werden Argumentationsschienen vorgestellt zur Vermittlung/Diskussion des erlernten Stoffes in der Tierzuchtpraxis und im Gespräch mit Fachleuten. Die gesellschaftspolitische Relevanz des Vorlesungsinhaltes wird vermittelt	**Arbeitsaufwand:** Präsenzzeit: 70 Stunden Selbststudium: 110 Stunden

Lehrveranstaltung: Reproduktionsbiotechnologie (Vorlesung, Exkursion, Übung) *Inhalte*: Fortpflanzungsbiologische Verfahren: Brunstkontrolle; Trächtigkeitsdiagnose; Besamung; Geburtssteuerung; Hormonelle Steuerung von Brunst, Ovulation und Geburt; Embryotransfer, IVP-Embryonen; Klonierung von Tieren; Stammzellen; Geschlechts- und Genotypbestimmung an Embryonen und Gameten; Microinjektion; Erstellung von Transgenen; Chimären; Gesetze und Verordnungen; Ethische Betrachtung und gesellschaftliche Akzeptanz fortpflanzungsbiologischer Verfahren.	5 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsvorleistungen:** Regelmäßige Teilnahme an den Exkursionen und Übungsstunden zu reproduktionsbiotechnologischen Verfahren **Prüfungsanforderungen:** Detaillierte Kenntnisse über reproduktionsbiotechnologische Methoden und Verfahren, die in der modernen Tierzucht und beim Menschen angewendet werden. In der Prüfung werden Wissens-, Könnens- und Transferfragengestellt, die die Lehrinhalte abdecken und die Reflexion des Erlernten bedingen.	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]:** Dr. med. vet. Carina Blaschka
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 40	

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]:** N. N.
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:	Arbeitsaufwand:
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.	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	6 C
Modul M.Agr.0075: Spezielle Tierhygiene, Tierseuchenbekämpfung und Tierhaltung *English title: Special animal hygiene, control of epidemics and livestock husbandry*	6 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Spezielle Tierhygiene, Tierseuchenbekämpfung und Tierhaltung (Praktikum, Vorlesung)	6 SWS
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 in 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 Symtomenkomplexe, 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 und HACCP-Verfahren 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 werden unterschiedliche Produktionseinheiten mit ihren Haltungsformen vorgestellt und das jeweilige Hygienemanagement analysiert. Jungtier-, Euter- und Klauenhygiene, Hygiene der Melktechnik, Fütterungshygiene sowie Besamungs- und Geburtshygiene sind dabei die Schwerpunkte. Das Modul vermittelt in Laborkursen darüber hinaus auch Kenntnisse einer zeitgemäßen mikrobiologischen und parasitologischen Labordiagnostik, in der heute molekularbiologische und	

immunologische Techniken zum Erreger- und Schadstoffnachweis im Vordergrund stehen.

Prüfung: Klausur (90 Minuten) **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]:** N. N.
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 60	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0076: Statistische Nutztiergenetik *English title: Statistical genetics of farm animals*	4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

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:	4 SWS

- 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.

Prüfung: Klausur (100 Minuten) **Prüfungsanforderungen:** Die Prüfung besteht aus einer computergestützten Auswertung und Interpretation von Beispieldaten (100 min).	6 C

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.

Zugangsvoraussetzungen:	Empfohlene Vorkenntnisse:
keine	keine
Sprache:	**Modulverantwortliche[r]:**
Deutsch	Dr. Ahmad Reza Sharifi
Angebotshäufigkeit:	**Dauer:**
jedes 4. Semester; Wintersemester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	
Maximale Studierendenzahl:	
20	

Georg-August-Universität Göttingen	6 C (Anteil SK: 6 C)
Modul M.Agr.0077: Themenzentriertes Seminar *English title: Themes centered seminar*	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 Teilnehmerinn 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	6 C
Modul M.Agr.0081: Verarbeitung pflanzlicher Produkte	4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Die Studenten 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.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Verarbeitung pflanlicher Produkte (Vorlesung, Übung)	4 SWS
Inhalte: Besonderheiten der Lebensmittelverarbeitung, thermische und mechanische Verfahren, Getreidetechnologie (erste und zweite Verarbeitungsstufe: Vermahlung, Backwarenherstellung), Nährmitteltechnologie (Reisverarbeitung, Teigwarenherstellung, Herstellung Extrudererzeugnissen), Ölsaatenverarbeitung Verarbeitung von Obst und Gemüse (Saftgewinnung, Herstellung von Konserven aus Obst und Gemüse, Sauerkrautherstellung), Übungen und Demonstrationen zu ausgewählten Verarbeitungsschritten, Exkursion	
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Grundlegende Kenntnisse in folgenden Bereichen: • Darstellung der Besonderheiten der Lebensmittelproduktion • Erläuterung von Verfahren der ersten und zweiten Verarbeitungsstufe von Getreide unter Berücksichtigung der Anforderungen an die Qualität von Rohstoffen und Endprodukten • Erläuterung von thermischen und mechanischen Verfahren die in Getreide- und Nährmittelherstellung sowie bei der Ölsaatenverarbeitung von Bedeutung sind • Darstellung der vorgestellten Verarbeitung von Obst und Gemüse	

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

Georg-August-Universität Göttingen **Modul M.Agr.0082: Verfahren in der Tierhaltung** *English title: Animal Husbandry Systems*	6 C 4 SWS

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.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

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.
	4 SWS

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.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Kenntnisse aus dem Bereich Nutztierhaltung werden erwartet.
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Imke Traulsen
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 27	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0083: Verfahrenstechnik und Elektronikeinsatz in der Pflanzenproduktion *English title: Process engineering and use of electronics in crop production*	4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Die Studierenden vertiefen ihre Kenntnisse auf dem Gebiet der Verfahrenstechnik der Pflanzenproduktionssysteme und des Einsatzes der Elektronik in verschiedenen Bereichen der Pflanzenproduktion. Sie können Verfahren und Techniken unter Berücksichtigung von Forschungsergebnissen und Praxiserfahrungen bewerten. Durch die selbständige Anfertigung eines Referats und einer Hausarbeit erlernen die Studierenden sich neues Wissen anzueignen und diese Kenntnisse vorzutragen und zu vertreten.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Verfahrenstechnik und Elektronikeinsatz in der Pflanzenproduktion (Vorlesung, Exkursion, Seminar) *Inhalte*: Vermittlung von Kenntnissen der Verfahrenstechnik der Pflanzenproduktion in den Bereichen: Getreide, Ölpflanzen, Zuckerrüben, Kartoffeln, Futterpflanzen, und Sonderkulturen. Bewertung der Verfahrenstechnik. Grundlagen des Elektronikeinsatzes; Einsatz der Elektronik in der Verfahrenstechnik der pflanzlichen Produktion (Ackerschlepper, Verteilarbeiten, Ernte, Konservierung, Logistik); Sensoren zur Erkennung von Pflanzenzuständen; Teilflächentechnik; Fahrerassistenzsysteme, Dokumentation; Einsatz und Verwendung von Geografischen Informationssystemen (GIS).	4 SWS
Prüfung: Hausarbeit (max. 20 Seiten, Gewichtung: 60%) und Präsentation, Referat oder Korreferat (ca. 20 Minuten, Gewichtung: 40%) **Prüfungsvorleistungen:** Referat (ca. 30 Min.) **Prüfungsanforderungen:** Vertiefte Kenntnisse auf dem Gebiet der Verfahrenstechnik der Pflanzenproduktionssysteme und des Einsatzes der Elektronik in verschiedenen Bereichen der Pflanzenproduktion. Kenntnisse über sämtliche Lehrinhalte, die als Vorlesung und in Vorträgen angeboten werden. Präsentation und Diskussion eines speziellen Themas mit anschließender schriftlicher Ausarbeitung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** N. N.
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**

zweimalig	
Maximale Studierendenzahl: 20	

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	3 C
Modul M.Agr.0088: Hymenoptera-Bestimmungskurs *English title: Idenification of Hymenoptera*	

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: Hausarbeit (Gewicht: 60%, Umfang: max. 20 Seiten) und Präsentation, Referat oder Korreferat (Gewicht: 40%, Dauer: ca. 20 Minuten) 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. Teja Tscharntke
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. Teja Tscharntke
Angebotshäufigkeit: jedes Semester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0091: Ertrags- und Stressphysiologie - experimentelles Versuchswesen *English title: Crop and stress physiology - experimental designs*	4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
Die Studierenden erlangen weiterführende Kenntnisse über spezielle Aspekte des Pflanzenbaus / Ertrags- Stressphysiologie einschließlich wichtiger Messmethoden zur experimentellen Bestimmung von ertrags- beeinflussenden Parametern. Sie sind in der Lage, sich selbstständig Kenntnisse über ein begrenztes Fachgebiet anzueignen und dieses Wissen mittels geeigneter Präsentationstechniken zu vermitteln. Sie erwerben die Fähigkeit, pflanzenbauliche Maßnahmen mittels statistischer Verfahren zu interpretieren und fachlich zu bewerten. Dieses kann als vorbereitender Abschnitt zur Hinführung an eine Masterarbeit gesehen werden.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Ertrags- und Stressphysiologie - experimentelles Versuchswesen (Vorlesung, Exkursion) *Inhalte*: Die Wechselwirkungen zwischen dem Einfluss der Umweltfaktoren auf die Prozesse der Ertragsbildung werden anhand von experimentellen Ansätzen beleuchtet. Schwerpunkt bilden die Interdependenzen zwischen den Gesetz- mäßigkeiten der Ertragsbildung und Qualitätsdynamik von Nahrungs-und Futterpflanzen sowie Nachwachsenden Rohstoffen, den Ertragsfaktoren und pflanzenbaulichen Maßnahmen unter sich verändernden Rahmenbedingun- gen (Klima). Aspekte der Stressphysiologie und Adaptionsmechanismen werden aufgezeigt. Auf die endogene Verteilung und intermediäre Speicher- ung der für das Pflanzenwachstum und die Ertragsbildung wichtigsten Stoff- klassen wird besonderes Augenmerk gelegt. Die Zusammenhänge werden am Beispiel ausgewählter Versuchsanstellungen veranschaulicht. Hierbei werden Grundzüge des wissenschaftlichen Versuchswesens vermittelt. Spezielle Punkte sind das Aufstellen einer Arbeitshypothese, sowie die Ver- suchsplanung, Parametrisierung, Durchführung und anschließende Aus- wertung. Für Aspekte aus benachbarten Disziplinen sollen weitere Lehrende einbezogen werden.	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Weiterführende Kenntnisse im Bereich Pflanzenbau, umfassende Kenntnisse über die Auswirkungen von Stress auf die Ertragsbildung Des Weiteren Grundkenntnisse im Bereich der statistischen Auswertung und der Versuchsplanung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Jörg Michael Greef
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester

Wiederholbarkeit:	Empfohlenes Fachsemester:
zweimalig	
Maximale Studierendenzahl:	
80	

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) **Prüfungsvorleistungen:** Präsentation (ca. 10 Min.) **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]:** Prof. Dr. Mark Varrelmann
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]:** apl. Prof. 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 4 WLH

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 root pressure probes and imaging techniques. Students will learn how to model root water uptake 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: 1. how hydraulic properties of soil and roots control water availability to plants 2. how plants modify and adapt to the soil properties 3. 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; soil degradation; soil protection.	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:** Jun.-Prof. Dr. Andrea Carminati
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 **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, Gewicht: 80%) und Präsentation, Referat oder Korreferat (ca. 15 Minuten, Gewicht: 20%) **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:	**Modulverantwortliche[r]:**

Deutsch	Prof. Dr. Klaus Dittert
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 45	

Georg-August-Universität Göttingen **Modul M.Agr.0104: Global Change and Soil Fertility** *English title: Global change and soil fertility*	3 C 2 SWS

Lernziele/Kompetenzen: Die Studierenden erlangen hierbei die Kompetenz, Ursachen und Mechanismen der Global Change auf die Böden und ihre Fruchtbarkeit und somit auf die lw Produktion zu evaluieren.	**Arbeitsaufwand:** Präsenzzeit: 24 Stunden Selbststudium: 66 Stunden

Lehrveranstaltung: Global Change and Soil Fertility (Vorlesung, Seminar) *Inhalte*: Effekte unterschiedlicher Komponenten des Global Change auf die Agrarökosysteme mit speziellem Fokus auf die Böden und ihre Fruchtbarkeit werden behandelt. Folgende Komponenten des Global Change werden diskutiert: • Änderungen des Klimaparameters: Temperatur, Niederschläge, Extremereignisse, elevated CO2, O3, UV • Landnutzungsänderungen, Erosion • Nährstoffkreisläufe • Populationswachstum: Urbanisierung, Migration • Ressourcenmangel: LW Fläche, Wasser, Nährstoffe • Chemische Pollution .... • Biodiversität und genetisch modifizierte Organismen Vorhersagen der zu erwartete Änderungen der Produktion für einige lw Kulturen, ausgewählte Regionen werden gemacht und mögliche Strategien zur Milderung ungünstiger Einflüsse bzw. zur Nutzung der positiven Effekte werden vorgeschlagen.	2 SWS
Prüfung: Präsentation, Referat oder Korreferat (Dauer ca. 20 Minuten) **Prüfungsvorleistungen:** Teilname an Seminaren **Prüfungsanforderungen:** Kenntnisse über die Ursachen und Mechanismen der Global Change auf die Böden und ihre Fruchtbarkeit.	3 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch, Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Yakov Kuzyakov
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

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. Ludwig Theuvsen
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 50	

Georg-August-Universität Göttingen	3 C
Modul M.Agr.0109: Plant-Water-Nutrient Relations in Semi-arid and Arid Agriculture	2 SWS
English title: Plant-Water-Nutrient Relations in Semi-arid and Arid Agriculture	

Lernziele/Kompetenzen:	Arbeitsaufwand:
Nach der Teilnahme sollen die Studierenden: • Die Interaktion von Wasser-und Nährstoffdynamik im System Pflanze-Boden diskutieren können und Maßnahmen entwickeln können, um deren Nutzungseffizienz zu erhöhen, • Kenntnisse über grundlegende Konzepte der Beziehung Pflanze-Wasser, Wasser und Pflanzenertrag und Trockenstressmanagement erworben haben, • Die Nährstoffphysiologie der Pflanze, Nährstofffunktionen und den Einfluss von Düngung auf den Ertrag in semi-ariden und ariden Klimazonen beschreiben können.	Präsenzzeit: 28 Stunden Selbststudium: 62 Stunden

Lehrveranstaltung: Plant-Water-Nutrient Relations in Semi-arid and Arid Agriculture (Praktikum, Vorlesung)	2 SWS
Inhalte: Theorie: In diesem Modul erwerben die Studierenden Wissen über Wassermangelprobleme im Pflanzenbau (saisonale und temporäre Trockenheit), CO_2 Assimilation und Transpiration bei C3 und C4 Pflanzenarten, Nährstoffkreisläufe in semi-ariden und ariden Klimazonen sowie den Einfluss von Pflanzen-Wasser-Nährstoff-Beziehungen auf die Wassernutzungseffizienz. Übung: Die Studierenden lernen neue Analysemethoden zur Bestimmung von Wassernutzungseffizienz, Gasaustausch, Thermographie, Chlorophyll-Fluoreszenz und die Arbeit mit stabilen Isotopen in der Wassernutzungseffizienzforschung kennen.	
Prüfung: Klausur (90 Minuten, Gewichtung: 80%) und Projektarbeit (max. 5 Seiten, Gewichtung: 20%) **Prüfungsvorleistungen:** Teilnahme an den Seminarvorträgen **Prüfungsanforderungen:** Grundlegende Kenntnisse der • Nährstoffkreisläufe in semi-ariden und ariden Klimazonen, • Symptome von Trockenstress auf Blatt-und Pflanzenniveau, • Rolle der Pflanzenernährung bei der Verbesserung der Trockenresistenz • Analysemethoden zur Bestimmung der Wassernutzungseffizienz auf Blatt-und Pflanzenniveau	3 C

Zugangsvoraussetzungen: keine	Empfohlene Vorkenntnisse: keine
Sprache: Englisch	**Modulverantwortliche[r]:** N. N.
Angebotshäufigkeit:	**Dauer:**

jedes Wintersemester	1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 45	

Georg-August-Universität Göttingen	6 C
Module M.Agr.0111: Applied Equilibrium Models for Agri-Food Markets	

Learning outcome, core skills:	Workload:
Good background in micro-economic theory;	Attendance time:
	56 h
Presentation of scientific results from literature review including technical details of	Self-study time:
model formulations;	124 h
Critical analysis and discussion of modeling results;	
Interest to learn and to apply the economic modeling software GAMS.	

Course: Applied Equilibrium Models for Agri-Food Markets (Block course, Exercise, Seminar)	WLH
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.	

Examination: Oral Presentation (approx. 20 minutes)	6 C
Examination requirements:	
Presentation and discussion of modeling results in English.	
Understanding of principles of equilibrium models for agri-food markets.	

Admission requirements:	Recommended previous knowledge:
none	none

Language:	Person responsible for module:
English	Dr. Martin Banse

Course frequency:	Duration:
each winter semester	1 semester[s]

Number of repeat examinations permitted:	Recommended semester:
twice	

Maximum number of students:	
20	

Georg-August-Universität Göttingen **Modul M.Agr.0112: Forschungsorientiertes Lehren und Lernen im Pflanzenbau: Experimentelle Studien zu wechselnden Themen** *English title: Research-based teaching and learning in agronomy: Experimental studies on varying topics*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden bearbeiten nach Anleitung ein eigenes Forschungsthema mit pflanzenbaulichem oder phytopathologischem Schwerpunkt. Grundlage hierfür sind Versuche im Feld, Gewächshaus und Labor. Die Feldversuche werden im Rahmen der Exkursion gemeinsam besichtigt. Die Veranstaltung orientiert sich am Vegetationsverlauf und beginnt daher grundsätzlich im Sommersemester. Im Seminar wird die Beschreibung der eigenen Ergebnisse in einer wissenschaftlichen Arbeit von der Einleitung bis zur Diskussion besprochen. Durch das Literaturstudium und die Präsentation vor der Gruppe sollen die Studierenden so lernen, die eigenen Ergebnisse in den wissenschaftlichen Kontext einzuordnen und zu diskutieren. Die Veranstaltung bereitet die Studierenden damit auf die kontinuierliche Bearbeitung einer experimentell ausgerichteten Masterarbeit vor.	**Arbeitsaufwand:** Präsenzzeit: 60 Stunden Selbststudium: 120 Stunden

Lehrveranstaltung: Forschungsorientiertes Lehren und Lernen im Pflanzenbau: Experimentelle Studien zu wechselnden Themen (Praktikum, Exkursion, Seminar) *Inhalte*: Pflanzenbaulicher Schwerpunkt: z. B. Bestandesentwicklung, physiologische Untersuchungen; Ertrag und Qualität verschiedener Kulturarten; Anbaugestaltung (Fruchtfolge, Düngung, Zwischenfrucht); bodenchemisch/-physikalische Untersuchungen; Abbau und Speicherung organischer Bodensubstanz; Bilanzierung von N, Energie, Treibhausgasen und Umweltwirkungen von Anbausystemen. Phytopathologischer Schwerpunkt: Pilzliche Erkrankungen von Zuckerrübe und Getreide; sterile Arbeitstechniken; Inokulumherstellung; Inokulationsversuche; Befallsbonitur; Auswirkung des Befalls auf agronomische Parameter; mikroskopische und molekulare Pathogenbestimmung. Allgemein: Selbständige Bearbeitung einer experimentellen Fragestellung; Erhebung von Mess- oder Boniturdaten; Datenauswertung; Literatursuche; wissenschaftliche Auswertung und Darstellung von Versuchen im Vortrag und in schriftlichen Arbeiten.	4 SWS
Prüfung: Präsentation oder Referat (Gewichtung: 40%; Dauer: ca. 20 Minuten) und Hausarbeit (Gewichtung: 60%; Umfang: max. 20 Seiten) **Prüfungsanforderungen:** Vertieftes Verständnis pflanzenbaulicher und phytopathologischer Zusammenhänge sowie deren wissenschaftliche Darstellung. Literatursuche und -verarbeitung, Rhetorik, Präsentation, Anfertigung der Hausarbeit.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** BSc. Nutzpflanzenwissenschaften o.ä.
Sprache: Deutsch	**Modulverantwortliche[r]:** apl. Prof. Anne-Katrin Mahlein

Angebotshäufigkeit:	Dauer:
jährlich	2 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	
Maximale Studierendenzahl:	
8	

Bemerkungen:
Das Modul beginnt jeweils im Sommersemester und muss in zwei aufeinander folgenden Semestern belegt werden.

Georg-August-Universität Göttingen **Module M.Agr.0113: Applied nutritional crop physiology**	3 C 2 WLH

Learning outcome, core skills: In this module students will: • learn the definitions of "source" and "sink" as they apply to assimilate partitioning, • understand how harvest index, and total biomass can be affected by plant nutrients and source-sink interactions, • learn new technological approaches that can be used for optimizing plant nutrition.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Applied Nutritional Crop Physiology (Internship, Lecture) *Contents*: Theory: In plant sciences the term growth is often used in a rather loose way: it may mean an increase in cell number, plant size, plant weight, or all of the above. However, increase of dry matter can occur without any further differentiation (e.g. deposition of storage compounds in grain, stem or root) and differentiation can occur without a concurrent increase in weight (e.g., germination and "growth" of seedlings in the dark). In this 3 credit module, we will study the role of plant nutrients on dry matter production and partitioning of crops. Emphasis will be placed on the understanding and qualitative measurement of physiological processes (photosynthesis, respiration, photorespiration); plant responses (leaf area, partitioning of dry mass, root length, and surface area, water status, and transpiration); and environmental parameters (radiation, moisture, carbon dioxide, wind, temperature). The integration of these measurements into models would help to better understand and predict crop growth and yield. Übung: Students will set up a greenhouse experiment in order to study remote sensing approaches (NDVI, and thermography) for determining nutrient uptake and biomass yield. A very simple computer simulation model will be established to simulate crop growth. Additionally, gas exchange and basic lab measurements will be used as complementary information.	2 WLH
Examination: Oral examination (approx. 20 minutes) **Examination requirements:** Knowledge in • effects of plant nutrients on crop physiology, • how changes in plant morphology and physiology affect productivity, • remote sensing of crop growth and simple computer modeling of crop growth.	3 C

Admission requirements: Teilnahme an den Seminarvorträgen	**Recommended previous knowledge:** none
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:	
18	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0114: Sicherheitsbewertung biotechnologischer Verfahren in der Pflanzenzüchtung	4 SWS
English title: Biosafety evaluation of biotechnological approaches in plant breeding	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	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.0115: Biogeochemie agrarisch genutzter Böden** *English title: Biogeochemistry of agricultural soils*	6 C 6 SWS

Lernziele/Kompetenzen: • Prozessverständnis für Umsätze innerhalb des C- und N-Kreislaufs in Böden; • Verständnis für den Einfluss landwirtschaftlicher Nutzung auf Flüsse und Umsätze in C- und N-Kreislauf; • Quantifizierung von C- und N-Flüssen mittels isotopenbasierter Methoden (Markierungsexperimente wie Pulselabeling, FACE-Experimente, C-3 – C-4 - Vegetationswechsel,…) • Aufbau von Humus aus pflanzlichen Rückständen (Charakterisierung von Streu, Rhizodepositen und organischer Bodensubstanz z.B. mittels Massenspektrometrie) • Anwendung molekularer Proxies zur Beschreibung mikrobieller Gemeinschaften in Böden und deren Beeinflussung durch landwirtschaftliche Nutzung Es sollen sowohl theoretische Grundlagen vermittelt werden als auch diese bei der Durchführung eigener Experimente inklusive der nachfolgenden biogeochemischen Analytik angewandt werden.	**Arbeitsaufwand:** Präsenzzeit: 84 Stunden Selbststudium: 96 Stunden

Lehrveranstaltung: Biogeochemie agrarisch genutzter Böden" (Vorlesung, Übung) *Inhalte*: Im Rahmen dieses Moduls sollen biogeochemische Prozesse v.a. des Kohlenstoffs- und Stickstoffkreislaufs und deren mikrobiologischen und molekulare Grundlagen beleuchtet werden. Der Einfluss landwirtschaftlicher Bewirtschaftung (Kulturart, Bodenbearbeitung, Düngung,…) auf die C- und N-Umsätze in landwirtschaftlich genutzten Systemen sollen verdeutlicht werden. Im speziellen sollen molekulare, bodenkundliche Methoden zur Erfassung von Stoffflüssen und -umsätzen des C-, N- und P-Kreislauf vorgestellt werden, wie z.B. isotopenbasierte Experimente. Außerdem soll ein Einblick in molekulare Proxies zur Beurteilung landwirtschaftlicher Böden gegeben werden, z.B. die massenspektrometrische Charakterisierung der organischen Bodensubstanz oder die Analyse pflanzlicher und mikrobieller Biomarker. Die Veranstaltung besteht aus Vorlesung und Laborpraktikum.	6 SWS
Prüfung: Mündlich (ca. 30 Minuten, Gewichtung: 50%) und Präsentation (ca. 15 Minuten) mit schriftlicher Ausarbeitung (max. 10 Seiten) (Gewichtung 50%) **Prüfungsanforderungen:** Verständnis für Stoffkreisläufe in Agrarökosystemen und deren Veränderung in Abhängigkeit von der Art der landwirtschaftlichen Nutzung; Kenntnis über Methoden zur Erfassung von Stoffkreisläufen und der molekularen Charakterisierung der organischen Bodensubstanz und mikrobiellen Gemeinschaft in Böden.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine

Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Michaela Dippold
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 25	

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 im 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: Klausur (60 Minuten, 50%) und Präsentation (ca. 20 Minunten) mit schriftlicher Ausarbeitung (max. 15 Seiten) (Gewichtung 50%) **Prüfungsanforderungen:** Das Modul besteht aus einem theoretischen Teil und einem anwendungsorientierten Projekt, in dem die Studierenden bei intensiver Betreuung eine aktuelle Themenstellung selbständig bearbeiten und präsentieren. In einer Klausur werden die erworbenen theoretischen Grundlagen geprüft. In der Hausarbeit stellen die Studierenden auf Basis ihrer erworbenen Theoriekenntnisse und der Ergebnisse der Projektarbeit in einer Hausarbeit eine Lösung für die vertieft behandelte 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 select appropriate diagnostic techniques for specific purposes and made informed decisions regarding developnebt and application of DNA-based diagnostic methods and molecular markers. They will recognize the role biotechnology in plant protection 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: electrophoresis (discovery of new viruses, detection of viroids, dsRNA in confirmation of hypovirulence, electrophoretic karyotypes); nucleic acid hybridization (spot hybridization, RFLP, ASO, macro- and microarrays in diagnostic); PCR and its variants incl. qPCR and digital PCR; ligase chain reaction; ; isothermal amplification; sources of primers and primer specificity. Miniaturization of diagnostic methods: laboratory on chip. Molecular markers: RAPD, AFLP, SSR, SNP; application of molecular markers in epidemiology of pathogens, analysis of population structure and genetic diversity, genome mapping, map-based gene cloning, and marker-assisted selection. Remote detection of plant pathogens: optical methods and VOC analysis. Biotechnology in plant protection: delimitation from agriculture and fermentation technologies; limits of genetic diversity in crops and its causes; techniques to increase genetic diversity and overcome incompatibility barriers; selection for resistance in tissue culture. Genetic engineering of crops: inactivation of genes on DNA and on transcript levels; introduction of foreign genes into crops: techniques, selection markers, safety, acceptance, legal aspects; GM crops in engineering resistance to viruses, pests, herbicides, bacterial and fungal pathogens. Genomic technologies in the development of plant protection technologies: genome analysis, NGS and third generation sequencing, omics, tagged saturation mutagenesis and high-throughput screening.	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: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Petr Karlovsky
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.0121: Nährstoffdynamik in der Rhizosphäre** *English title: Nutrient dynamics in the rhizosphere*	6 C 4 SWS

Lernziele/Kompetenzen: Nutzung von mathematischen Modellen und Ergebnisinterpretation zur Bearbeitung wissenschaftlicher Themen. Die Studenten erlernen eine wissenschaftliche Fragestellung im Versuch zu bearbeiten und die Ergebnisse im wissenschaftlichen Vortrag vorzustellen.	**Arbeitsaufwand:** Präsenzzeit: 80 Stunden Selbststudium: 100 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.	4 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.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Bernd Steingrobe
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 24	

Georg-August-Universität Göttingen **Modul M.Agr.0122: Vertriebsmanagement im Agribusiness** *English title: Sales Management im 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:	Modulverantwortliche[r]:
Deutsch	Prof. Dr. Achim Spiller
Angebotshäufigkeit:	**Dauer:**
jedes 4. Semester; Start WS 15/16	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	Master: 1 - 3
Maximale Studierendenzahl:	
50	

Georg-August-Universität Göttingen **Modul M.Agr.0123: Bodengeographische und Agrarökologische Feldübungen** *English title: Soil geographical and agroecological field studies*	9 C 6 SWS

Lernziele/Kompetenzen: Fachbezogene Kenntnisse der Bodenbildung und –nutzung, Ökosystemare Zusammenhänge, Biogeochemische Kreisläufe.	**Arbeitsaufwand:** Präsenzzeit: 192 Stunden Selbststudium: 78 Stunden

Lehrveranstaltung: Bodengeographische und Agrarökologische (Übung, Seminar) *Inhalte*: Die Lehrveranstaltung soll einen Querschnitt durch mehrere Klimazonen aufzeigen: Besonderheiten der Bodenbildung und -nutzung, sowie Landwirtschaft werden in Zusammenhang mit Klima, Vegetation, Geomorphologie, Nährstoff- und Wasserkreisläufen im Ökosystem und Landschaft erläutert. Typische Böden unveränderter, natürlicher Ökosysteme werden prozessorientiert beschrieben und mit ackerbaulich genutzten Böden verglichen. Rückschlüsse auf die Änderung des Prozessgefüges in Böden durch ackerbauliche Nutzung werden gemeinsam im Gelände erarbeitet. Großversuche zur Landschafts- und Agrarraumgestaltung, Biosphärenreservate und Naturschutzgebiete sowie und landwirtschaftliche Betriebe verschiedener Betriebsstrukturen werden besichtigt.	9 SWS
Prüfung: Präsentation (2x ca. 30 Minuten) (Gewichtung 50%) und Hausarbeit (max. 15 Seiten) (Gewichtung 50%) **Prüfungsanforderungen:** Vorbereitendes Seminar: Kenntnisse des Klimas der temperierter Ökosysteme, Prozesse der Bodenbildung und –nutzung und/oder Prinzipien der Aufbau der WRB-Bodenklassifikation sollen anhand eines Bodentyps aufgezeigt werden; Nachbereitendes Seminar: tiefgehendes, im Rahmen der Exkursion erarbeitetes Prozessverständnis über Bodenbildungsprozesse und biogeochemische Stoffkreisläufe soll herausgearbeitet und präsentiert werden. In einer bis zu 15seitigen Hausarbeit soll die Fähigkeit zu wissenschaftlichem Schreiben basierend auf dem behandelten biogeochemischen Themenkomplex aufgezeigt werden.	9 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch, Englisch	**Modulverantwortliche[r]:** Prof. Dr. Yakov Kuzyakov
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

20	

Georg-August-Universität Göttingen **Modul M.Agr.0124: Environmental Economics and Policy** *English title: Environmental Economics and Policy*	6 C 4 SWS

Lernziele/Kompetenzen: Dieses Modul vermittelt umweltökonomische und ressourcenökonomische Grundlagen und vertiefende Kenntnisse in ausgewählten Bereichen. Die Studierenden erlernen dabei die grundlegenden theoretischen Konzepte und Methoden der Umweltökonomik. Darüber hinaus lernen die Studierenden die Bedeutung von Politikmaßnahmen zu bewerten. In diesem Kurs wird ein besonderer Schwerpunkt auf internationale und globale Herausforderungen gelegt (z.B. Klimawandel).	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Environmental Economics and Policy (Vorlesung, Übung) *Inhalte*: • Eigentumsrechte, Externalitäten und Umwelt • Effizienz and Nachhaltigkeit • Bewertung der Umwelt • Ausgewählte Themen der Ressourcenökonomie (Land, Common-pool resources) • Perspektiven der Umweltpolitik (command&control versus incentives) • Globale Umweltherausforderungen (z.B. Klimawandel) • Entwicklung und Umwelt	4 SWS
Prüfung: Klausur (90 Minuten) **Prüfungsanforderungen:** Die Studierenden können vertieftes Fachwissen in den oben genannten Themenbereichen vorweisen. Sie können die erlernten theoretischen Konzepte und Methoden erklären und anwenden und umweltökonomische Politikmaßnahmen bewerten.	6 C

Zugangsvoraussetzungen: Grundlagen der Agrarökonomie und/oder Mikroökonomie	**Empfohlene Vorkenntnisse:** keine
Sprache: Englisch	**Modulverantwortliche[r]:** Prof. Dr. Meike Wollni
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 60	

Bemerkungen: Die Prüfung kann auch auf Deutsch abgelegt werden.

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 Gesell-schaft, 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.0144: Intensivseminar Bewässerungstechnik** *English title: Intensive seminar irrigation technology*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen Kenntnisse und Grundwissen zur Bewässerungstechnik in der Landwirtschaft.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Intensivseminar Bewässerungstechnik (Exkursion, Übung, Seminar) *Inhalte*: • Einführung, Wasserressourcen und Verfügbarkeit • Grundwasser und Brunnenbau • Rechtliche Grundlagen und Bewirtschaftung • Interaktion Wasser-Boden-Pflanze • Wasserförderung / Pumptechnik • Wasserverteilung: Oberflächenbewässerung, Beregnung, Mikrobewässerung • Fallbeispiele und Exkursion Lehrbuchempfehlung: Rickman, M. and Sourell, H.: Bewässerung in der Landwirtschaft, ISBN 978-3-86263-089-9	4 SWS
Prüfung: Mündlich (ca. 25 Minuten) **Prüfungsanforderungen:** Kenntnisse zu Wasserressourcen, deren Verfügbarkeit, Grundwasser und Brunnenbau. Basiswissen zu rechtlichen Grundlagen und Bewirtschaftung. Kenntnis der Interaktion Wasser-Boden-Pflanze. Wissen zu Möglichkeiten der Wasserförderung / Pumptechnik und der Wasserverteilung.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** Pflanzenbau, Bodenkunde
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Frank Beneke
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 15	

Georg-August-Universität Göttingen **Modul M.Agr.0145: Datenmanagement und Auswertung pflanzen-baulicher 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 verstehen Messabläufe mit unterschiedlichen Sensoren zu planen, durchzuführen und die gewonnen Daten mit geeigneten Methoden zu interpretieren.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Digitale Technologien in der Pflanzenproduktion (Vorlesung, Übung) *Inhalte*: Im Rahmen des Moduls werden den Studierenden ausgewählte digitale Technologien und ihr technisches Umfeld für den Einsatz in pflanzlichen Produktionssystemen vorgestellt. Des Weiteren werden deren theoretische und praktische Anwendung vermittelt. Die o.g. Technologien umfassen z.B. Geoinformationssysteme für den Pflanzenbau (GIS), GPS, Trägerplattformen (Robotics, UAV, traktorgestützte Systeme) und Sensoren (Thermografie, NIR / hyperspektrale Verfahren, 3D-Systeme, Chlorophyllfluoreszenz und RGB-Methoden) zur Erfassung von Pflanzenzuständen und Ertragsparametern. Möglichkeiten zum Einsatz dieser Verfahren und Potentiale auf unterschiedlichen Skalenebenen - von in-vitro Systemen (Grundlagenforschung) bis hin zu Feldapplikationen (Vehikel- oder Flugobjekt-gestützt) - werden vorgestellt und kritisch diskutiert. Erforderliche Aspekte des Data Handlings (Big Data) und der Datenanalyse (Maschinelles Lernen) sowie die Einbindung in Farmmanagementsysteme werden vermittelt. Der Schwerpunkt liegt auf den Anwendungsbereichen Precision Agriculture (Smart Farming) und Plant Phenotyping. Berücksichtigt werden Applikationen im Acker-, Obst- und Gemüsebau. Im Rahmen der Übung lernen die Studierenden optische Sensoren zur Erfassung von Pflanzenzuständen auszuwählen und einzusetzen. Neben der Planung von Messsituationen und Steuerung der Sensorik ermitteln die Studierenden von Ground truth Daten (Referenzdaten) und interpretieren die gewonnenen Sensordaten mittels geeigneten Datenanalysemethoden. 1. Digitale Technologien in der Pflanzenproduktion (Vorlesung) 2. Fallbeispiele zur Detektion von Pflanzenstress mittels optischen Sensoren (Übung) 3. N-Sensor und Drohnenbefliegung (Übung)	4 SWS

Prüfung: Präsentation (ca. 15 Minuten, Gewichtung 25%) mit schriftlicher Ausarbeitung (max. 15 Seiten, Gewichtung 75%) **Prüfungsvorleistungen:** regelmäßige Teilnahme an der Übung, Vortrag (ca. 15 Min.) **Prüfungsanforderungen:**	6 C

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.

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	keine
Sprache:	**Modulverantwortliche[r]:**
Deutsch	apl. Prof. Anne-Katrin Mahlein
Angebotshäufigkeit:	**Dauer:**
jedes Sommersemester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	
Maximale Studierendenzahl:	
25	

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.0079 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 4 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 Nutztieren bzw. durch 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: 90 Stunden Selbststudium: 90 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);	4 SWS
Prüfung: Protokoll (max. 25 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:**

Bestandes Modul Reproduktionsbiotechnologie (M.Agr.0069)	Grundlagen von Fortpflanzung und Leistung beim Nutzsäuger (B.Agr.0331)
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. med. vet. Carina Blaschka
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 **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 proof 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 clean • interpreting data and results through the use of graphical tools. The produced code has to handed in along with the paper and will also be subject to the evaluation.	6 C

Admission requirements: Econometrics I (*M.WIWI-QMW.004*) or equivalent	**Recommended previous knowledge:** Basic econometric techniques
Language: English	**Person responsible for module:** Prof. Dr. Bernhard Brümmer
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 15	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0152: Nachhaltigkeitswissenschaft	4 SWS
English title: Sustainability Science	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Nachhaltigkeitswissenschaft (Vorlesung, Seminar)	4 SWS
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.	

Prüfung: Klausur (60 Minuten, 50%) und Referat (ca. 30 Minuten, 50%)	6 C
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.	

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.0153: Ökonomik und Management natürlicher Ressourcen** *English title: Natural Resources Economics and Management*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden erlernen grundlegende Konzepte und Methoden der Umwelt- und Ressourcenökonomik. Einen Schwerpunkt bildet die ökonomische Bewertung von Ökosystemleistungen verschiedener Landnutzungssysteme, v.a. von sogenannten Nicht-Markt-Gütern. Weiterhin lernen die Studierenden Methoden zur Bewertung von politischen Entscheidungen, wie z.B. der Kosten-Nutzen-Analyse, kennen. Darüber hinaus machen sie sich mit gängigen Politikinstrumenten zur Schaffung von Handlungsanreizen zur Förderung einer nachhaltigen Landnutzung vertraut.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Ökonomik und Management natürlicher Ressourcen (Vorlesung, Übung, Seminar) *Inhalte*: 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 und Methoden gezielt selbstständig vertiefen und ihre Anwendung in einer Fallstudie bewerten können. Inhalte: • Grundlegende umweltökonomische Konzepte, Nicht-Markt-Güter, Marktversagen, Umweltprobleme in der Landwirtschaft • Natürliche Ressourcen, Eigentumsrechte, Öffentliche Güter und Allmendegüter in Landnutzungssystemen • Kosten-Nutzen-Analyse (KNA) u.a. Methoden zur Bewertung von Handlungsalternativen (z.B. hinsichtlich verschiedener landwirtschaftlicher Produktionssysteme) • Ökosystemleistungsansatz, Wertbereiche (Total Economic Value – TEV) • Ökonomische Bewertung von Ökosystemleistungen, Methoden • Politikinstrumente: Regulatorische und marktbasierte Anreizsysteme (Agrar-Umweltprogramme)	4 SWS

Prüfung: Klausur (60 Minuten, 70%) und Präsentation (ca. 20 Minuten, 30%) **Prüfungsanforderungen:** Grundlegende Kenntnisse zu wichtigen grundlegenden Konzepten der Umwelt-und Ressourcenökonomie. Einordnung von Ökosystemleistungen und Wertbereichen. Kenntnisse gängiger Methoden der ökonomischen Bewertung und ihrer Anwendbarkeit. Diskussion des Einsatzes von Entscheidungshilfen, wie der KNA und der Vor- und Nachteile gängiger Politikinstrumente.	6 C

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Meike Wollni
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 30	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0155: Systemanalyse ackerbaulicher Produktionsver-fahren	4 SWS
English title: Analysis Crop Production	

Lernziele/Kompetenzen:	Arbeitsaufwand:
• 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.	Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Systemanalyse ackerbaulicher Produktionsverfahren (Vorlesung, Exkursion)	4 SWS
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	
Prüfung: Klausur (90 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]:** apl. Prof. Anne-Katrin Mahlein
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 60	

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.0158: Strategische Wissenschaftskommunikation: Praktiken und Wirkungen** *English title: Strategic Science Communication: Practices and Effects*	6 C 4 SWS

Lernziele/Kompetenzen: Die Studierenden lernen Akteure und Publika strategischer Wissenschafts-kommunikation sowie die Wirkungen von Kommunikationsmaßnahmen in verschiedenen Kommunikationsszenarien kennen. Nach Abschluss des Moduls haben die Studierenden folgende Fähigkeiten: • Sie kennen die Akteure öffentlicher Wissenschaftskommunikation und können ihre Interessen und Kommunikationsstrategien einschätzen • Sie können Krisenfälle strategischer Kommunikation diagnostizieren (Kontroversen, Skandale, Shitstorms) und kennen ihre typischen Verlaufsformen • Sie können Zielgruppen strategischer Wissenschaftskommunikation definieren und wissen, mit welchen Inhalten und über welche Kanäle sie sie erreichen können • Sie wissen, wie öffentliche Wissenschaftskommunikation in unterschiedlichen Szenarien und bei unterschiedlichen Zielgruppen wirken (können) • Sie können sich kommunikationswissenschaftliche Erkenntnisse zunutze machen, um in konkreten Fällen effektive Kommunikationsstrategien zu entwerfen	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Strategische Wissenschaftskommunikation: Praktiken und Wirkungen (Übung, Seminar) *Inhalte*: Die Studierenden erhalten einen Einblick in das Handlungsfeld der strategischen (Wissenschafts-)kommunikation. Im Mittelpunkt des Moduls stehen die Wirkungen verschiedener Kommunikationsmaßnahmen für verschiedene Kommunikationsszenarien. Im Seminar werden evidenz-basiert für konkrete Kommunikationsprobleme Handlungsempfehlungen in Gruppen herausgearbeitet und reflektiert. Das Seminar wird ergänzt durch eine Übung, in der grundlegende Wirkungstheorien vermittelt und erarbeitet werden. Literatur: Kepplinger, M. (2018). Medien und Skandale. Springer VS. Raupp, J. (2017). Strategische Wissenschaftskommunikation. In H. Bonfadelli et al. (Hrsg.), Forschungsfeld Wissenschaftskommunikation (S. 143-164). Wiesbaden: Springer VS. *Angebotshäufigkeit:* jedes Wintersemester	4 SWS
Prüfung: Präsentation (ca. 30 Minuten, Gewichtung 70%) und Referat (ca. 15 Minuten, Gewichtung 30%) **Prüfungsanforderungen:** Folgende Kenntnisse sind prüfungsrelevant: 1. Kenntnisse gängiger Ansätze der Medienwirkungsforschung; 2. Überblick über verschiedene Kommunikationsszenarien und entsprechende Maßnahmen 3. Formulierung und Reflektion von Handlungsempfehlungen	6 C

Zugangsvoraussetzungen:	Empfohlene Vorkenntnisse:
keine	Empfohlen wird der Besuch der Vorlesung „Öffentliche Kontroversen um Umwelt, Technologie und Wissenschaft" (ab WS 2019/2020)
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Senja Post
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 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 **Modul M.Agr.0171: Dynamiken öffentlicher Kontroversen um Wissenschaft, Technologie und Umwelt** *English title: Dynamics of public controversies over science, technology, and the environment*	6 C 4 SWS

Lernziele/Kompetenzen: Die öffentliche Kommunikation über Technologie, Wissenschaft und Umwelt ist vor allem dann besonders intensiv und folgenreich, wenn Wissenschaft und Technik politisiert und kontrovers diskutiert werden. Beispiele hierfür finden sich in zahlreichen Debatten, die die Landwirtschaft betreffen: um die Anwendung von Biotechnologien und Pflanzenschutzmitteln, den Einsatz von Robotik-Technologien, die Tierhaltung, die Biodiversität u.v.a.m. Ziel des Moduls ist es, den Teilnehmenden typische Verlaufsmuster solcher Kontroversen zu vermitteln und sie zu befähigen, die Wirkungen öffentlicher Kommunikation einzuschätzen. Nach Abschluss des Moduls haben die Studierenden folgende Fähigkeiten: • Sie kennen typische Verlaufsformen öffentlicher Kontroversen um Umwelt, Technologien und Wissenschaft; • Sie kennen Akteure, die an solchen Kontroversen beteiligt sind und können ihre Ziele, Interessen und Kommunikationsstrategien einschätzen; • Sie können Auswahlmechanismen von Medien und Verbreitungswege von Kommunikationsinhalten einschätzen; • Sie wissen, wie die Inhalte öffentlicher Kommunikation auf unterschiedliche Akteure wirken, wie sie die Dynamiken von Kontroversen und gesellschaftliche Prozesse beeinflussen können; • Sie kennen die Dynamiken aktueller Agrarkontroversen und können die Folgen von Kommunikationsmaßnahmen in konkreten Fällen einschätzen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Dynamiken öffentlicher Kontroversen um Wissenschaft, Technologie und Umwelt (Vorlesung, Übung) *Inhalte*: Gegenstand sind öffentliche Kontroversen um Wissenschaft, Technologie und Umwelt. Im Mittelpunkt stehen Kommunikationsinhalte sowie ihre Verbreitung und Wirkungen auf involvierte Akteure (z. B. Konfliktgegner, Politiker) und unbeteiligte Beobachter (z. B. Konsumenten). In der Vorlesung werden kommunikationswissenschaftliche Grundbegriffe, theoretische Ansätze zur Erklärung der Dynamiken öffentlicher Kontroversen sowie empirische Befunde vermittelt. In der begleitenden Übung werden die Inhalte der Vorlesung vertieft und im Kontext aktueller Agrarkontroversen diskutiert.	4 SWS

Prüfung: Kurzvortrag in der Übung (15 Minuten,30%), Klausur am Ende der Vorlesung (60 Minuten, 70%)	6 C

Prüfungsvorleistungen:

Kurzvortrag in der Übung (15 Minuten,30%), Klausur am Ende der Vorlesung (60 Minuten, 70%)

Prüfungsanforderungen:

Folgende Kenntnisse sind prüfungsrelevant:

1. Die in Vorlesung und Übung vermittelten kommunikationswissenschaftlichen Begriffe, Theorien und Befunde;
2. Fälle / Probleme der Wissenschaftskommunikation in aktuellen Agrarkontroversen.

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Senja Post
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:** ab 2
Maximale Studierendenzahl: 60	

Georg-August-Universität Göttingen **Modul M.Agr.0172: Evaluation von Wissenschaftskommunikation** *English title: Evaluation of Science Communication*	6 C 4 SWS

| **Lernziele/Kompetenzen:**
Akteure des Agrarsystems (Landwirte, Verbände, NGOs) stehen häufig großen kommunikativen Herausforderungen gegenüber – dem mangelnden Wissen der Bevölkerung, dem Misstrauen der Konsumenten, einer unsachlichen Berichterstattung u.v.a.m. Häufig reagieren Akteure auf solche Herausforderungen mit konkreten Kommunikationsmaßnahmen. Doch wie erfolgversprechend oder wirksam sind einzelne Maßnahmen? Um diese Frage zu beantworten, müssen Kommunikationsmaßnahmen im Vorhinein oder im Nachhinein evaluiert – also auf ihre Wirksamkeit geprüft werden. Die Teilnehmenden des Moduls lernen, wie konkrete Kommunikationsmaßnahmen evaluiert werden können. Dies soll sie befähigen, im Berufsleben Evaluationen strategischer Kommunikationsmaßnahmen selbst durchzuführen oder in Auftrag zu geben.

Nach Abschluss des Moduls haben die Studierenden folgende Fähigkeiten:

• Sie können die Wirkungen von Wissenschaftskommunikation in aktuellen Agrarkontroversen einschätzen;
• Sie kennen Methoden empirischer Kommunikationsforschung und wissen, für welche Fragestellungen sie angewandt werden;
• Sie wissen, wie Praktiken und Instrumente strategischer Kommunikation empirisch evaluiert werden können. | **Arbeitsaufwand:**
Präsenzzeit:
56 Stunden
Selbststudium:
124 Stunden |

| **Lehrveranstaltung: Evaluation von Wissenschaftskommunikation** (Vorlesung, Übung)
Inhalte:
Die Studierenden erhalten zunächst einen Überblick über die Methoden empirischer Kommunikationsforschung; anschließend wenden sie empirische Methoden im Rahmen eines kleinen Forschungsprojekts an, um die Wirksamkeit einer konkreten Kommunikationsmaßnahme zu prüfen.

Im Seminar werden zunächst grundlegende Methoden empirischer Kommunikationsforschung vermittelt. In der begleitenden Übung wenden die Teilnehmenden in Gruppenarbeit eine ausgewählte Methode an, um die Wirksamkeit einer konkreten Kommunikationsmaßnahme zu prüfen. Anschließend werden die erhobenen Daten ausgewertet und aufbereitet. Die Forschungsprojekte werden am Ende des Semesters im Seminar präsentiert. | 4 SWS |

| **Prüfung: Vortrag mit schriftlicher AusarbeitungPräsentation der Evaluationsergebnisse (Vortrag ca. 20 Min., 20%) im Seminar und schriftliche Ausarbeitung (max. 20 Seiten, 80%)**
Prüfungsvorleistungen:
Präsentation der Evaluationsergebnisse (Vortrag ca. 20 Min., 20%) im Seminar und schriftliche Ausarbeitung (max. 20 Seiten, 80%) | 6 C |

Prüfungsanforderungen:

Folgende Kenntnisse sind prüfungsrelevant:

1. Kenntnisse der Methoden empirischer Kommunikationsforschung
   (z. B. quantitative Inhaltsanalyse, Befragung, Stichprobenziehung,
   sozialwissenschaftliches Experiment);
2. Anwendung empirischer Forschungsmethoden;
3. Auswertung und Aufbereitung empirischer Forschungsdaten.

Zugangsvoraussetzungen:	**Empfohlene Vorkenntnisse:**
keine	Empfohlen wird der vorherige Besuch des Moduls „Strategische Wissenschafts-kommunikation: Praktiken und Wirkungen"
Sprache:	**Modulverantwortliche[r]:**
Deutsch	Prof. Dr. Senja Post
Angebotshäufigkeit:	**Dauer:**
jedes Wintersemester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	ab 2
Maximale Studierendenzahl:	
30	

Georg-August-Universität Göttingen	3 C
Module M.Agr.0173: Nematology	2 WLH

Learning outcome, core skills:	Workload:
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.	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	

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.	**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 and basic training to create own videos.	4 WLH

Examination: Written exam (45 min, 50%), Student presentation with discussion (ca. 20 min presentation + ca. 10 min discussion 50%) **Examination requirements:** an style="text-decoration: underline;">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. an style="text-decoration: underline;">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.	

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	3 C
Modul M.Agr.0175: Plant-Herbivore Interactions (Experimental course)	2 SWS
English title: Plant-Herbivore Interactions (Experimental course)	

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	Präsenzzeit: 40 Stunden Selbststudium: 50 Stunden

Lehrveranstaltung: Plant-Herbivore Interactions (Experimental course) (Übung, Seminar)	2 SWS
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	

Prüfung: Benotetes Protokoll über die durchgeführten Experimente Prüfungsanforderungen:	
Dokumentation und Interpretation der durchgeführten Versuche entsprechend dem wissenschaftlichen Standard. Seminarvortrag	

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	6 C
Modul M.Agr.0176: Gesundheitsorientiertes Lebensmittelmarketing	4 SWS
English title: Gesundheitsorientiertes Lebensmittelmarketing	

Lernziele/Kompetenzen:	Arbeitsaufwand:
- Theorien, Strategien und Marketinginstrumente kennenlernen, welche für das gesundheitsorientierte Lebensmittelmarketing von Relevanz sind - ausgewählte aktuelle Forschungsergebnisse zum gesundheitsorientierten Lebensmittelmarketing verstehen - qualitative und quantitative Methoden der Markt- und Konsumforschung kennenlernen und in einer empirischen Projektarbeit anwenden	Präsenzzeit: 30 Stunden Selbststudium: 150 Stunden

Lehrveranstaltung: Gesundheitsorientiertes Lebensmittelmarketing (Vorlesung)	4 SWS
Inhalte: Im Rahmen des Moduls werden Theorien und Strategien behandelt, welche in Bezug auf das gesundheitsorientierte Lebensmittelmarketing von Relevanz sind. Es wird zudem auf die verschiedenen Marketinginstrumente eingegangen. Vorgestellt und diskutiert werden aktuelle Forschungsergebnisse zum gesundheitsorientierten Lebensmittelmarketing. Im Modul werden darüber hinaus qualitative und quantitative Methoden der Markt- und Konsumforschung behandelt. In einer begleitenden empirischen Projektarbeit zu einer aktuellen Fragestellung werden die Methoden von den Studierenden praktisch angewendet.	

Prüfung: Hausarbeit (max. 15 Seiten)	
Prüfungsanforderungen: Im Rahmen des Moduls wird eine empirische Projektarbeit zu einer aktuellen Fragestellung durchgeführt. Zur empirischen Projektarbeit wird von den Studierenden eine Hausarbeit verfasst.	

Zugangsvoraussetzungen: keine	Empfohlene Vorkenntnisse: keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. phil. Sina Nitzko
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

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]:** Prof. Dr. Petr Karlovsky
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

12	

Georg-August-Universität Göttingen **Modul M.Forst.1411: Modellierung von Populationsdynamik und Bio-diversität** *English title: Modelling of Population Dynamics and Biodiversity*	6 C 4 SWS

Lernziele/Kompetenzen: Verständnis der Auswirkungen von außenbürtigen Einflussfaktoren und innenbürtigen Regelmechanismen auf die Veränderung von Populationsstrukturen. Verbindung von beschreibenden mit modellierenden Ansätzen und Systemanalyse.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Modellierung von Populationsdynamik und Biodiversität (Seminar) *Inhalte*: Die Veranstaltung besteht aus drei aufeinander abgestimmten Teilveranstaltungen,"Modelle der Populationsdynamik und Biodiversität" (2 SWS), "Populationsdynamik und Regelsysteme" (1 SWS) und "Populationsgenetische Modelle" (1 SWS). Das gemeinsame Ziel besteht darin, die Auswirkungen von außenbürtigen Einflußfaktoren und innenbürtigen Regelmechanismen auf die Veränderung von Populationsstrukturen (zum Beispiel Dichten und Alterklassenverteilungen) kennen zu lernen. Soweit außenbürtige Einflussfaktoren biotischer Natur sind, werden sie in das biozönotische Wechselwirkungsgefüge eingeordnet, welches die ökologischen Kreisläufe organisiert. Die waldbauliche Steuerung und Nutzung wird in Form außenbürtiger Einflußnahmen auf die Dynamik von Populationsstrukturen untersucht und auf ihre Nachhaltigkeit geprüft. Durch die Verbindung von beschreibenden mit modellierenden Ansätzen wird in die systemanalytische Methode eingeführt.	4 SWS
Prüfung: Klausur (90 Minuten)	6 C

Prüfungsanforderungen: Kenntnisse der Modellierung von Populationsdynamik, Genetik und Biodiversität, insbesondere der Modellierung von Ausbrüchen von Insektenpopulationen in Wäldern und der genetischen Konsequenzen menschlicher Einflüsse.	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Prof. Dr. Kerstin Wiegand
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: nicht begrenzt	

Georg-August-Universität Göttingen **Modul M.Forst.1422: Fernerkundung und GIS** *English title: Remote Sensing and GIS*	6 C 4 SWS

Lernziele/Kompetenzen: Ziel der Veranstaltung ist es, den Studierenden einen umfassenden Einblick in die wesentlichen Arbeitsabläufe der fernerkundlichen digitalen Bildverarbeitung zu geben. Der GIS-Teil ermöglicht überdies eine Erweiterung der im Bachelorstudium erworbenen grundlegenden GIS-Kenntnisse. Es werden Methoden vorgestellt, mit denen das räumliche Nebeneinander von Geoobjekten analysiert werden kann. Die Lehrveranstaltung versetzt die Studierenden in die Lage, selbstständig Projekte auf raumbezogener Datenbasis, ausgehend von der fernerkundlichen Informations¬extraktion aus digitalen Bilddaten bis zur Analyse der generierten Geoobjekte, zu bearbeiten. Die in Vorlesungen und Übungen vermittelten Kenntnisse orientieren sich dabei an den aktuellen Anforderungen raumbezogener interdisziplinärer Forschungsprojekte.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Fernerkundung und GIS (Vorlesung, Übung) *Inhalte*: Grundlagen (Elektromagnetische Strahlung und Aufbau digitaler Bilder), Prin¬zipien der Atmosphärenkorrektur, Bildstatistik und Bildverbesserung, überwachte und unüberwachte Bildklassifizierung, Vegetationsindizes, Genauig¬keits¬analyse, multitemporale Analyse, geometrische Korrektur und Orthobild-Herstellung (Woche 1 bis 7). Definition von Untersuchungsgebieten, Maskierung, Zellengröße und Zellenlage im Raum, Definition von Analysefenstern, Data-Nodata-Behandlung, Umwand¬lung von Vektor- zu Rasterdaten, Rasterdatenformate, mathematische Funktionen als Beispiel für lokale Funktionen, fokale Funktionen im Zusammenhang mit Geländehöhendaten, zonale Funktionen im Zusam¬menhang mit der Forst¬einrich¬tung, Distanzfunktionen (Woche 8 bis 14).	4 SWS
Prüfung: Klausur (120 Minuten)	6 C

Prüfungsanforderungen: Nachweis der Kenntnis der physikalischen und informatischen Grundlagen der Bildverarbeitung und Klassifikation der Inhalte digitaler Bilder, Verständnis der Fachterminologie, Fähigkeit zur Lösung einfacher Aufgabenstellungen in den Bereichen Genauigkeitsanalyse, geometrische Korrekturverfahren und Transformation in Orthobilder, Spezifikation von Masken und Analysefenstern, Transformation zwischen Vektor- und Rasterdarstellung von Geometrien; Kompetenzen bei der Behandlung von fehlenden Daten und Noise und bei der Wahl geeigneter Datenformate, Lösung von Problemstellungen unter Einsatz von fokalen, zonalen und Distanzfunktionen. In „Fernerkundung" sollen die Studierenden zu Themen- und Problembereichen Kenntnisse und Fähigkeiten nachweisen, so wie sie im Modul behandelt werden; dies schließt die folgenden ein: • Grundlagen elektromagnetischer Strahlung und deren Interaktion mit der Atmosphäre und mit Landbedeckungsformen;	

- Grundlegende Techniken der Fernerkundungsbildvorbereitung, - Bearbeitung, - Verbesserung und -Klassifizierung, wie in den Übungen behandelt;
- Kenntnisse und Fähigkeiten bei der Anwendung der Software, die in den Übungen verwendet wird;
- Optionen der Anwendung von Fernerkundung in Waldinventuren sowohl für Kartierungen qie für die Verbesserung von Schätzungen;
- Beurteilung der Qualität von Fernerkundungs-Bildprodukten, einschließlich Genauigkeitsanalyse.

Zugangsvoraussetzungen:	Empfohlene Vorkenntnisse:
keine	Erforderlich sind Kenntnisse in den der Kartographie, der Fernerkundung, der deskriptiven Statistik und der einfachen Stichprobenstatistik (entsprechend der 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: nicht begrenzt	

Georg-August-Universität Göttingen **Modul M.Forst.1424: Computergestützte Datenanalyse** *English title: Computer Based Data Analysis*	6 C 4 SWS

Lernziele/Kompetenzen: Kenntnis von grundlegenden Versuchsplänen und wichtigen Verfahren und Modellen der statistischen Datenanalyse. Fähigkeit zur selbständigen Anlage eines Experimentes und zur Auswahl eines geeigneten statistischen Analyseverfahrens einschließlich Prüfung der Voraussetzungen und Auswertung mit Statistik-Software.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Computergestützte Datenanalyse (Vorlesung, Übung) *Inhalte*: Einführung in wichtige statistische Modelle, Testverfahren und Versuchspläne: deskriptive Statistik; Anpassungstests; Kreuztabellen und Chiquadrat-Tests; einfache, multiple und schrittweise Regression; t-Tests und ein- und zweifaktorielle Varianzanalyse; Transformationen; randomisierte Versuchpläne und randomisierte Blockversuche; Kovarianzanalyse. Versuche mit Messwiederholungen, nichtlineare Regression, logistische Regression, Fehlerfortpflanzung, Rangtests, Hauptkomponentenanalyse, Geostatistik. Zusätzlich zu den theoretischen Grundlagen wird in den Übungen eine Einführung in die Benutzung einerStatistik-Software zur Datenanalyse gegeben und werden die diskutierten statistischen Verfahren auf konkrete Experimente und Datensätze angewendet, die Analyseergebnisse diskutiert und interpretiert.	4 SWS
Prüfung: Klausur (120 Minuten)	6 C

Prüfungsanforderungen: • Daten in eine Statistik-Software einlesen und eine explorative Datenanalyse durchführen • Daten grafisch darstellen • Passende statistische Verfahren oder Modelle zur Datenanalyse auswählen • Vor- und Nachteile statistischer Verfahren oder Modelle erörtern • Statistische Verfahren oder Modelle auf gegebene Daten anwenden • Annahmen statistischer Verfahren oder Modelle erläutern und testen • Ergebnisse der Datenanalyse interpretieren • Sinnvolle Folgeanalysen vorschlagen	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine
Sprache: Deutsch	**Modulverantwortliche[r]:** Dr. Katrin Mareike Meyer
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl:	

20	

Georg-August-Universität Göttingen **Module M.Forst.1620: Agent-based modelling with NetLogo**	6 C 4 WLH

Learning outcome, core skills: • 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	**Workload:** 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	6 C
Modul M.Forst.1654: Böden der Welt: Verbreitung, Eigenschaften und Nutzung *English title: Soils of the Earth: Distribution, Characteristics and Use*	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: Kenntnis der beschriebenen Lehrinhalte, Erreichung der festgelegten Lernziele und Nachweis der angestrebten Kompetenzen.	

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	9 C
Modul M.Forst.1655: Bodenchemische Übung	6 SWS
English title: Soil Chemistry Exercise	

Lernziele/Kompetenzen:	Arbeitsaufwand:
Aufbauend auf die im Bachelorstudiengang vermittelten Grundkenntnisse zur Bodenkunde werden die wichtigsten analytischen Ansätze und Verfahrensweisen zur ökochemischen Charakterisierung von Bodenproben vermittelt. Ziel ist neben der Erfassung von theoretischen Grundlagen die eigenständige Durchführung aller wesentlichen Analyseschritte, die Aus- und Bewertung der erzeugten Datensätze im Kontext der Bodenökologie sowie die Schaffung einer Grundlage für weitere eigenständige Laborarbeiten. 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.	Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Bodenchemische Übung (Vorlesung, Übung)	6 SWS
Inhalte: Zunächst werden theoretische Grundlagen und Ansätze zu den wichtigsten bodenanalytischen Herangehensweisen vermittelt (u.a. chemische Gleichgewichte, Austausch- und Bindungskapazitäten, Aggregatzustände). Hinzu kommt die Einführung in die wichtigsten analytischen Protokolle und Verfahrensweisen sowie deren praktische Anwendung. Dazu zählt u.a. die Probengewinnung, die Aufarbeitung, das Aufschließen oder Extrahieren von Bodenproben sowie die Erstellung Kontrolle der eigenen Analytik mittels Standards oder Blindproben. Abschließend erfolgt eine kritische Aus- und Bewertung der eigenständig erzeugten Daten. *Angebotshäufigkeit:* jedes Wintersemester	

Prüfung: Protokolle	9 C

Prüfungsanforderungen:	
Vertiefte Kenntnisse der bodenchemischen Charakterisierung von Waldstandorten und Verständnis bodenökologischer Zusammenhänge. Methodische Fertigkeiten im Bereich bodenchemischer Analytik. Bewertung und Interpretation von Messergebnissen.	

Zugangsvoraussetzungen: Grundlegende Kenntnisse in Bodenkunde	Empfohlene Vorkenntnisse: keine
Sprache: Deutsch	Modulverantwortliche[r]: Prof. Dr. Norbert Lamersdorf
Angebotshäufigkeit: jedes Sommersemester	Dauer: 1 Semester
Wiederholbarkeit: gemäß Prüfungs- und Studienordnung	Empfohlenes Fachsemester:

Maximale Studierendenzahl:	
12	

Georg-August-Universität Göttingen **Modul M.Forst.1656: 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 Studenten 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.1657: Bodenmikrobiologische Übung** *English title: Practice in Soil Microbiology*	9 C 6 SWS

Lernziele/Kompetenzen: Fähigkeit zur Anwendung bodenmikrobiologischer Methoden und Bewertung der Ergebnisse im ökologischen Zusammenhang.	Arbeitsaufwand: Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden

Lehrveranstaltung: Bodenmikrobiologische Übung (Übung) *Inhalte*: Im Rahmen des Praktikums werden die TeilnehmerInnen im Erlernen und in der Anwendung verschiedener bodenmikrobiologischer Methoden angeleitet, die zur Erhebung ökologisch relevanter Kenngrößen dienen. Die mikrobiologischen Kenngrößen sollen in Relation zu verschiedenen Einflussgrößen (Bodennutzung, Bodentiefe, Temperatur) ausgewertet werden. Die Anwendung mikrobieller Parameter zur Beschreibung des physiologischen Zustandes der mikrobiellen Gemeinschaften in unterschiedlichen Ökosystemen soll erlernt werden. Darüber hinaus ist ein wichtiges Ziel, dass die Teilnehmer mehr oder weniger selbstständig erhobene Daten auswerten, die Ergebnisse angemessen darstellen, sie interpretieren können und in einem größeren Kontext (in diesem Fall der Bedeutung verschiedener Rahmenbedingungen für die Menge und die Leistung der Bodenmikroflora) schriftlich wie mündlich präsentieren. Außerdem soll erlernt werden, wissenschaftliche Originalliteratur zu verstehen und ihren Inhalt in Vortragsform zu vermitteln.	6 SWS
Prüfung: Referat (ca. 15 Minuten) und Protokoll (max. 15 Seiten)	9 C

Prüfungsanforderungen: Kenntnis der beschriebenen Lehrinhalte, Erreichung der festgelegten Lernziele und Nachweis der angestrebten Kompetenzen.	

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 **Modul M.Forst.1685: Ökologische Modellierung** *English title: Ecological Modelling*	6 C 4 SWS

Lernziele/Kompetenzen: • Kenntnis der behandelten Modellierungstechniken; • Fähigkeit, eine geeignete Modelliertechnik für eine gegebene Fragestellung im Bereich der Ökologie auszuwählen und eigenständig anzuwenden; • den aktuellen Stand der Forschung in der ökologischen Modellierung kennen lernen; • kritische Wertschätzung und Diskussion von Forschungsergebnissen; • Präsentationstechniken üben und verfeinern; • konstruktives Feedback geben und nehmen.	**Arbeitsaufwand:** Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden

Lehrveranstaltung: Simulationsmodelle (Vorlesung, Übung) *Inhalte*: Modellierung ökologischer Prozesse mit Schwerpunkt auf Simulationsmodellen; Kennenlernen und eigenständiges Implementieren von Matrizenmodellen und regelbasierten, individuenbasierten und räumlichen Simulationsmodellen; Einführung in die Modellierung mit MS Excel und NetLogo; Integration quantitativer und qualitativer Daten; Musterorientierte Modellierung; Modellskalierung; Validierung; Sensitivitätsanalyse; Szenariengestaltung und -analyse; Modellinhalte: Populationsgefährdungsanalyse als Artenschutz-Tool (Matrizen und individuenbasiert); Bedeutung von Raum in der Vegetationsmodellierung;	3 SWS
Prüfung: Klausur (60 Minuten)	4 C

Lehrveranstaltung: Current topics in ecological modelling (Seminar) *Inhalte*: Vorstellung aktueller Publikationen oder eigener Forschungsergebnisse seitens der Teilnehmer; Vorstellung schließt die Diskussionsleitung und -stimulation ein; Teampräsentationen mit Pro- und Kontra-VertreterInnen möglich; strukturiertes Feedback zur Präsentation;	1 SWS
Prüfung: Referat (ca. 20 Minuten) mit schriftl. Ausarbeitung (max. 1 Seite)	2 C

Prüfungsanforderungen: • Modelltypen, die in der Ökologie angewandt werden, kennen, erläutern, anwenden, analysieren und beurteilen • Stadien der Modellentwicklung entlang des Modellierungszyklusses kennen, erläutern, anwenden, analysieren und beurteilen • Publizierte Modellstudien erfassen, zusammenfassen, ihre Möglichkeiten und Grenzen aufzeigen und diskutieren • Präsentationen und Diskussionen leiten und moderieren	

Zugangsvoraussetzungen: keine	**Empfohlene Vorkenntnisse:** keine

Sprache:	Modulverantwortliche[r]:
Deutsch	Prof. Dr. Kerstin Wiegand
Angebotshäufigkeit:	**Dauer:**
jedes Sommersemester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
gemäß Prüfungs- und Studienordnung	
Maximale Studierendenzahl:	
20	

Bemerkungen:
Beide Teilmodule auch für andere Studiengänge, wie MSc "Biologische Diversität und Ökologie", MSc "Agrawissenschaften", Studienrichtung Ressourcenmanagement verwendbar.

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. Frank Liebert
Angebotshäufigkeit: jedes Sommersemester	**Dauer:** 1 Semester

Wiederholbarkeit:	Empfohlenes Fachsemester:
zweimalig	
Maximale Studierendenzahl:	
40	

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:** Tiefer 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. Vertiefen Kenntnisse und Fertigkeiten im Hinblick auf die Vorstellung und Kommunikation der eigenen Projektarbeit sind vorhanden.	6 C

Zugangsvoraussetzungen:	Empfohlene Vorkenntnisse:
keine	keine
Sprache:	**Modulverantwortliche[r]:**
Deutsch	Prof. Dr. Johannes Isselstein
Angebotshäufigkeit:	**Dauer:**
jedes Sommersemester	1 Semester
Wiederholbarkeit:	**Empfohlenes Fachsemester:**
zweimalig	
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 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 and poverty in developing countries. Apart from more conceptual issues and development theories, policy strategies for rural development and poverty alleviation are discussed and analyzed. Special emphasis is put on problems in the small farm sector. Numerous empirical examples are used to illustrate the main topics.	4 WLH
Examination: Written examination (90 minutes) Examination requirements: Concepts and measurement of hunger and poverty; development theory; 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. Matin Qaim
Course frequency: each winter semester; Göttingen	Duration: 1 semester[s]
Number of repeat examinations permitted: twice	Recommended semester:
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: Students are familiar with empirical, quantitative methods in rural development economics. Thus, they are able to develop and implement their own research projects.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Quantitative research methods in rural development economics (Lecture) *Contents*: This module teaches and trains methodological skills for the analysis of micro data in rural development economics. In particular, farm and household level data are used. Apart from statistical and econometric techniques, approaches of primary data collection are covered (questionnaire development, survey sampling design). These methods are used for concrete examples in the computer lab.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Use and interpretation of descriptive statistics and standard econometric methods; hypothesis testing; data management; sampling design.	6 C

Admission requirements: Familiarity with the contents of the module "Socioeconomics of Rural Development and Food Security" is assumed.	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Matin Qaim
Course frequency: each summer 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.

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. Matin Qaim
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	6 C
Universität Kassel/Witzenhausen	4 WLH
Module M.SIA.E14: Evaluation of rural development projects and policies	

Learning outcome, core skills:	Workload:
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.	Attendance time: 40 h Self-study time: 140 h

Course: Evaluation of rural development projects and policies (Lecture)	4 WLH
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.	
Examination: Written exam (90 minutes, 50%) and presentation (ca. 25 minutes, 50%) **Examination requirements:** Cost-benefit analysis; development project evaluation; impact assessment; targeting of projects and interventions	6 C

Admission requirements:	Recommended previous knowledge:
none	Knowledge of the content of the module "Socioeconomics of Rural Development and Food Security" is required.
Language: English	**Person responsible for module:** Prof. Dr. Matin Qaim
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)
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
	4 WLH

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	6 C
Universität Kassel/Witzenhausen	4 SWS
Modul M.SIA.E24: Topics in Rural Development Economics I *English title: Topics in rural development economics I*	

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	6 C
Universität Kassel/Witzenhausen	4 WLH
Module M.SIA.E34: Economic valuation of ecosystem services in developing countries	

Learning outcome, core skills:	**Workload:**
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 development. Students will familiarize themselves with common methods of economic valuation of ES and learn about different examples of practical implementation in developing countries. Within the scope of a presentation and a term paper, students will review and evaluate selected scientific literature, process the findings in an environmental-economic analysis and compile results and derived policy recommendations for better maintenance, sustainable use and integration of ES into development planning.	Attendance time: 56 h Self-study time: 124 h

Course: Economic valuation of ecosystem services in developing countries (Seminar)	4 WLH
Contents: • Integrated and interdisciplinary analysis of ES • Dynamic linkages between ES, biodiversity, climate change and development • Methods and applications of economic valuation of ES • Implementation examples from developing countries • Integration of ES in development planning (entry points to the policy cycle) • Practical application in a case study (literature work, monetary quantification)	

Examination: Term paper (max. 20 pages, 70%) and oral presentation (approx. 30 minutes, 30%)	6 C
Examination requirements: For a given case study students will develop appropriate analytical strategies and implement them with the help of identified scientific literature. Methodological knowledge provided during the lectures will be essential for the case work. Most relevant results will be summarized in a presentation. The compilation of the term paper requires basic techniques of scientific literature research.	

Admission requirements:	**Recommended previous knowledge:**
none	M.Agr.0079 Environmental Economics and Policy or similar skills
Language:	**Person responsible for module:**
English	Prof. Dr. Meike Wollni
Course frequency:	**Duration:**
each winter semester; Göttingen	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	

Maximum number of students:	
30	

Georg-August-Universität Göttingen	6 C
Universität Kassel/Witzenhausen	4 WLH
Module M.SIA.E40: Agriculture, Environment and Development	

Learning outcome, core skills:	**Workload:**
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.	Attendance time: 56 h Self-study time: 124 h

Course: Agriculture, Environment and Development (Lecture, Exercise, Seminar)	4 WLH
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	

Examination: Klausur (60 Minuten, 70%) und Präsentation (ca. 20 Minuten, 30%)	6 C
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.	

Admission requirements:	**Recommended previous knowledge:**
none	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	6 C
Universität Kassel/Witzenhausen	4 WLH
Module M.SIA.I08: Organic farming under European conditions	

Learning outcome, core skills:	Workload:
Students understand and are able to evaluate farming systems and their underlying multifunctional objectives. Students are able to discuss and judge standards of organic agriculture.	Attendance time: 56 h Self-study time: 124 h

Course: Organic farming under European conditions (Lecture, Seminar)	4 WLH
Contents: • Presentation and discussion of selected literature • Definition of farming systems, multifunctional objectives • Methods for testing and improving the set of objectives • Comparison of standards of organic agriculture (IFOAM, EU, AGOEL)	

Examination: Oral exam (ca. 20 minutes, 50%) and presentation (ca. 15-20 minutes, 50%)	6 C
Examination requirements: Kenntnisse der Definition von Landnutzungssystemen und deren multifunktionalen Zielen. Wissen der Methoden zur Verbesserung und Überprüfung der Ziele, sowie Kenntnisse über die Richtlinien der ökologischen Landwirtschaft.	

Admission requirements: none	Recommended previous knowledge: Basic knowledge in soil and plant sciences
Language: English	Person responsible for module: apl. Prof. Dr. Peter von Fragstein
Course frequency: each summer 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: Lecture based materials.

Georg-August-Universität Göttingen	6 C
Universität Kassel/Witzenhausen	4 WLH
Module M.SIA.I10M: Applied statistical modelling	

Learning outcome, core skills:	**Workload:**
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.	Attendance time: 84 h Self-study time: 96 h

Course: Applied statistical modelling	4 WLH
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	
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:	**Recommended previous knowledge:**
none	Basic knowledge (B.Sc. level) of applied statistics
Language:	**Person responsible for module:**
English	Prof. Dr. Bernard Ludwig
Course frequency:	**Duration:**
each summer semester; Witzenhausen	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	6 C
Universität Kassel/Witzenhausen	6 WLH
Module M.SIA.P08: Pests and diseases of tropical crops	

Learning outcome, core skills:	Workload:
Students should become familiar with the causes of diseases (abiotic & biotic diseases), with the taxonomy of disease agents (bacteria, fungi, virus) and insect pests, with basics of integrated pest management (approaches, economic threshold, epidemiology), and biological, cultural control (cultivars, crop rotation, planting term, manual control), and chemical control options (toxicology, fungicides, insecticides) of the main crops in subtropical and tropical regions.	Attendance time: 84 h Self-study time: 96 h

Course: Pests and diseases of tropical crops (Lecture, Seminar)	6 WLH
Contents: Pests and diseases of selected crops are treated together for each crop including approaches to integrated control. The following crops will be presented: rice, maize, cotton, cocoa, coffee, cassava, phaseolus beans, bananas, and others. For each crop, a short introduction to botanical and agronomic features (as far as they concern disease or pest control) is given, together with an overview of the main diseases world-wide. The economic importance of diseases and pests in different geographical areas is discussed. The most important diseases and pests of die crop are treated in detail and die possibilities for integrated control are discussed. Short introductions (reviews) on basic subjects of plant protection are given, these include: causes of diseases (abiotic & biotic diseases), taxonomy of disease agents (bacteria, fungi, viruses) and insect pests, integrated pest management (approaches, economic threshold), biological control (diseases, pests), cultural control (varieties, crop rotation, planting term, manual control), and chemical control (toxicology, fungicides, insecticides). Students will give seminars on related topics. Vorlesungsbasierte Literatur	

Examination: Written exam (60 minutes, 67%) and presentation (ca. 20 minutes, 33%) Examination prerequisites: Seminar speech Examination requirements: Knowledge on the most important pests and diseases of tropical and subtropical crops; chemical and biological control options, phytosanitary approaches, and sustainable cropping systems for tropical crops.	6 C

Admission requirements:	Recommended previous knowledge:
none	Basic knowledge (B.Sc. level) in agricultural entomology, plant diseases and plant production
Language: English	**Person responsible for module:** Prof. Dr. Stefan Vidal
Course frequency:	**Duration:**

each summer semester; Göttingen	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Additional notes and regulations:

Literature:

Lecture based materials; details provided during lectures.

Georg-August-Universität Göttingen	9 C
Universität Kassel/Witzenhausen	8 WLH
Module M.SIA.P23M: Modern Plant Nutrition - Application of Molecular Methods in Plant Nutrition Research	

Learning outcome, core skills:	**Workload:**
Den Studenten werden neben den theoretischen Hintergründen, den Vor- und Nachteilen der einzelnen Methoden auch instrumentelle (analytische) Kompetenzen vermittelt. Sie erlernen, die ermittelten Daten zu interpretieren, untereinander in Beziehung zu setzen und im Kontext zu analysieren. Weiterhin werden sie befähigt, im Team zu arbeiten, sich gegenseitig über Informationen, Probleme und Lösungen auszutauschen und Methoden zielgerichtet einzusetzen	Attendance time: 120 h Self-study time: 150 h
Zu den hier vermittelten Methoden gehören u.a. die Extraktion von DNA, RNA und Proteinen aus verschiedenen Proben, PCR und qPCR inklusive des Primerdesigns, 2D-Gelelektrophorese, sowie Methoden zur Sequenzierung und aktuelle Tools zur Datenauswertung	

Course: Modern Plant Nutrition - Application of Molecular Methods in Plant Nutrition Research (Block course, Internship, Lecture)	8 WLH
Contents:	
Im Rahmen dieses Blockmoduls werden den Studenten aktuelle molekulare Methoden und deren Anwendung zur Beantwortung pflanzenernährerischer Fragestellungen vermittelt. Dazu werden die Studenten in die theoretischen Hintergründe der jeweiligen Methoden eingewiesen und anschließend diese Methoden praktisch anhand einer gezielten Fragestellung auch angewendet. Ziel ist es dabei Methodenkompetenz im Bereich der molekularen Analyse von mikrobiellen Gemeinschaften, mikrobiellen und pflanzlichen Genen und ihren Transkripten, sowie zur Analyse von Proteinen zu vermitteln. Beginnend bei der Planung und Vorbereitung solcher Analysen, über die Durchführung bis hin zur Auswertung und Interpretation der so gewonnenen Daten	

Examination: Klausur (90 Minuten, 75%) und mündliche Prüfung (ca. 15 Minuten, 25%)	9 C
Examination requirements:	
Kenntnisse über die im Modul vermittelten Methoden, sowie die theoretischen Hintergründe, Vor- und Nachteile, sowie die Anwendungsbereiche der jeweiligen Methoden. Des Weiteren Wissen über die Zusammenhänge von molekularen Mechanismen innerhalb der Pflanze und dem Einfluss der Verfügbarkeit einzelner Nährstoffe auf pflanzenphysiologische Parameter. Kenntnisse über die Rolle mikrobieller Gemeinschaften für die Pflanzenernährung und über Methoden zur Analyse dieser mikrobiellen Gemeinschaften und deren Aktivität, in Boden und Pflanze.	

Admission requirements:	**Recommended previous knowledge:**
none	Grundkenntnisse (B.Sc.Niveau) in Boden- und Pflanzenwissenschaften
Language:	**Person responsible for module:**
English	Jun.-Prof. Dr. Merle Tränkner

Course frequency:	Duration:
each summer semester; Göttingen	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	
Maximum number of students:	
15	

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: Oral examination (approx. 20 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:** Dr. Mehmet Gültas
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:
Recommended previous knowledge: Basic knowledge of R	none
Language:	**Person responsible for module:**
English	Dr. Mehmet Gültas
Course frequency:	**Duration:**
each winter semester	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	
Maximum number of students:	
25	

Georg-August-Universität Göttingen **Module M.iPAB.0017: Applied Bioinformatics with R**	6 C 4 WLH

Learning outcome, core skills: This module will cover the fundamental concepts of bioinformatics. Topics will include usage of relevant/modern biological databases and tools that are required to perform different analyses. Further, an introduction to multi-omics-data will be given, including genome, trancriptome and proteome analysis. This module aims to teach interested students fundamental analysis skills to evaluate biological data using bioinformatic techniques, and to become proficient in performing such analyses. In more detail, following topics will be treated: • Analysis of multi-omics data • Standard databases in bioinformatics • DNA sequence and genome analysis • Variant calling techniques • Sequence alignment • Gene regulatory network analysis • Clustering The lecture will be based on the analysis of real data sets from agricultural research projects as far as possible.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Applied Bioinformatics with R (Lecture, Exercise) *Contents*: The course consists of lectures, exercises and a project work. After the lectures and the exercises the students will have to carry out a project work that must be finished within ten 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, 75%) and term paper (max. 10 pages, 25%) **Examination requirements:** • Knowledge about the fundamental concepts of bioinformatics • Knowledge about different databases in bioinformatics • Analysis of biological data, interpretation and modeling og biological information and applying this to the solution of biological problems in any area involving molecular data.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of R
Language: English	**Person responsible for module:** Dr. Mehmet Gültas
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.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:** Dr. Mehmet Gültas
Course frequency: each semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Fakultät für Agrarwissenschaften:

Nach Beschluss des Fakultätsrats der Fakultät für Agrarwissenschaften vom 12.12.2019 hat das Präsidium der Georg-August-Universität am 21.01.2020 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).

Die Neufassung des Modulverzeichnisses tritt nach seiner Bekanntmachung in den Amtlichen Mitteilungen II zum 01.04.2020 in Kraft.

Fakultät für Agrarwissenschaften:

Nach Beschluss des Fakultätsrats der Fakultät für Agrarwissenschaften vom 12.12.2019 hat das Präsidium der Georg-August-Universität am 21.01.2020 die Neufassung des Modulverzeichnisses zur Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang

Modulverzeichnis

zu der Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang "Integrated Plant and Animal Breeding" (Amtliche Mitteilungen I Nr. 7/2019 S. 60, zuletzt geändert durch Amtliche Mitteilungen I Nr. 5/2020 S. 103)

Module

Inhaltsverzeichnis

Übersicht nach Modulgruppen

I. Master-Studiengang "Integrated Plant and Animal Breeding"

1. Block A - Compulsory Modules

The following four compulsory modules worth overall 27 C must be successfully completed.

2. Block B - Elective compulsory modules A

Out of the following elective compulsory modules at least four modules worth overall at least 21 C must be successfully completed.

3. Block C - Elective compulsory modules B

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.

4. Block D - Key competencies

The following two compulsory modules worth overall 12 C must be successfully completed.

5. Master's thesis

Completion of the Master's thesis is worth 24 Credits.

6. Colloquium for the Master's thesis

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)

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

The following five compulsory modules worth overall 33 C must be successfully completed:

2. Block B - Elective compulsory modules

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.

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d. Other modules

e. Alternative modules

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]:** Prof. Dr. Timothy Mathes Beissinger
Angebotshäufigkeit: jedes Wintersemester	**Dauer:** 1 Semester
Wiederholbarkeit: zweimalig	**Empfohlenes Fachsemester:**
Maximale Studierendenzahl: 20	

Georg-August-Universität Göttingen	6 C
Modul M.Agr.0114: Sicherheitsbewertung biotechnologischer Verfahren in der Pflanzenzüchtung *English title: Biosafety evaluation of biotechnological approaches in plant breeding*	4 SWS

Lernziele/Kompetenzen:	**Arbeitsaufwand:**
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.	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.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	6 C
Module M.Cp.0016: Practical statistics and experimental design in agriculture	4 WLH

Learning outcome, core skills:	Workload:
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.	Attendance time: 56 h Self-study time: 124 h

Course: Practical Statistics and Experimental Design in Agriculture (Lecture, Exercise)	4 WLH
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.	

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:** Master: 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Forst.1524: Biotechnology and forest genetics**	6 C 4 WLH

Learning outcome, core skills: Biotechnology is a fast developing field with many aspects and options in efficient and environmentally friendly bioresource production and utilization of bioresources including plant biomass. Sustainable management of tropical forests requires an understanding of the spatial and temporal dynamics of genetic information both in natural and man-made tropical forest ecosystems. The teaching module gives introductory lectures into biotechnology and into forest genetics.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Biotechnology (Lecture) *Contents*: Students will be introduced into subjects of microbiology, biochemistry and molecular biology being basics for biotechnology. With the gained knowledge, modern biotechnological applications in the forest and the wood industry sectors and the progress of biotechnological biomass conversion will be discussed, as well as other environmental problems that might be solved by biotechnological approaches on industrial scales and, particularly in tropical countries, also by small family business.	2 WLH
Examination: Oral examination (approx. 15 minutes)	3 C

Course: Tropical forest genetics (Lecture) *Contents*: 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.	2 WLH
Examination: Oral examination (approx. 15 minutes)	3 C

Examination requirements: Kenntnis der beschriebenen Lehrinhalte, Erreichung der festgelegten Lernziele und Nachweis der angestrebten Kompetenzen.	

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:	**Recommended semester:**

cf. examination regulations	
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:** N. N.
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	6 C
Universität Kassel/Witzenhausen	4 WLH
Module M.SIA.A14: Organic livestock farming under temperate conditions	

Learning outcome, core skills:	**Workload:**
Advances in animal nutrition and animal health:	Attendance time: 60 h
Students get to know scientific tools for quantifying, assessing and evaluating problems within organic livestock production.	Self-study time: 120 h
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.	

Course: Advances in animal nutrition and animal health (Lecture)	1,33 WLH
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	
Course: Animal welfare (Lecture) *Contents*: • Principles of animal welfare in relation to organic farming; scientific methods of welfare assessment	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:	Recommended previous knowledge:
none	Basic knowledge (B.Sc. level) of animal sciences
Language:	**Person responsible for module:**
English	Prof. Dr. Albert Sundrum
Course frequency:	**Duration:**
each summer semester; Witzenhausen	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	
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 <u>structure and format</u> of various types of scientific texts; • search <u>scientific literature</u>, set up and manage an electronic literature database and compile reference lists; • <u>write</u> term papers, grant proposals, conference abstracts, and final thesis (chapters); • compile scientific <u>tables and figures</u> and be able to decide which type of data is best expressed in which format; • apply the rules of <u>good scientific practice;</u> • give and receive constructive <u>feedback</u> 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 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 and poverty in developing countries. Apart from more conceptual issues and development theories, policy strategies for rural development and poverty alleviation are discussed and analyzed. Special emphasis is put on problems in the small farm sector. Numerous empirical examples are used to illustrate the main topics.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Concepts and measurement of hunger and poverty; development theory; 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. Matin Qaim
Course frequency: each winter semester; Göttingen	Duration: 1 semester[s]
Number of repeat examinations permitted: twice	Recommended semester:
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. Matin Qaim
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: 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
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
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:	Recommended previous knowledge:
none	none
Language:	**Person responsible for module:**
English	Dr. Thomas Möckel
Course frequency:	**Duration:**
each winter semester; Witzenhausen	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	
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	6 C
Universität Kassel/Witzenhausen	4 WLH
Module M.SIA.P13: Agrobiodiversity and plant genetic resources in the tropics	

Learning outcome, core skills:	Workload:
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.	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:	Recommended previous knowledge:
none	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. Henner Simianer
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 Presentation (about 20 minutes) with written outline (max. 10 pages) (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:** Prof. Dr. Timothy Mathes Beissinger
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 1
Maximum number of students: 20	

Additional notes and regulations: Mandatory excursions to practical plant breeding and animal breeding programs.

Georg-August-Universität Göttingen	6 C
Georg-August-Universität Göttingen **Module M.iPAB.0003: Statistical genetics, breeding informatics and experimental design**	6 C 4 WLH

Learning outcome	Workload
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	WLH
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:	Recommended previous knowledge:
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	9 C
Module M.iPAB.0004: Internship	6 WLH

Learning outcome, core skills:	Workload:
Specialized knowledge of the respective field, social competences (working organization, teamwork, interdisciplinary working, flexibility), applied methodical competences.	Attendance time: 240 h Self-study time: 30 h

Course: Internship (Internship)	6 WLH
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	
Examination: Term paper (max. 20 pages, 50%) and presentation (about 20 minutes, 50%) **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:** Dr. sc. agr. 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	6 C
Module M.iPAB.0006: Breeding informatics	4 WLH

Learning outcome, core skills:	**Workload:**
Students acquire their knowledge of informatics methods to evaluate large datasets for breeding issues.	Attendance time: 56 h Self-study time: 124 h

Course: Breeding informatics (Lecture, Exercise)	4 WLH
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	
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	6 C
Module M.iPAB.0007: Biotechnology and molecular genetics in plant and animal breeding	4 WLH

Learning outcome, core skills:	**Workload:**
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.	Attendance time: 56 h Self-study time: 124 h

Course: Biotechnology and molecular genetics in plant and animal breeding	4 WLH
(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.)	
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 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.Agr.0131	**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: twice	**Recommended semester:** 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: Written exam (45 minutes, 50%) and presentation (about 20 minutes, 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.	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**	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. Henner Simianer
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.0011: Seed marketing**	6 C 4 WLH

Learning outcome, core skills: Students can apply the tools of marketing to the specifics of the researchintensive seed market. They will be able to apply modern research methods in order to collect information on agricultural procurement processes and public settings. On this basis they can develop targeted strategies for national and international markets. They know customized concepts and methods of distribution.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Seed marketing (Seminar) *Contents*: The marketing of seed is a hitherto largely unexplored field of research. In the researchoriented master's degree program, the students will learn the basics of the businessto- business marketing (positioning, market segmentation, competitive strategies, international marketing, marketing tools, sales management) and its application to the purchasing behavior of farmers. Since the seed market is a socially critical debated topic, fundamentals of public relations and the corporate social responsibility are taught. In a project report in the second part of the seminar, students will elaborate their own studies on current aspects of the seed marketing and present it in a presentation.	4 WLH

Examination: Written exam (60 minutes, 50%) and presentation (about 30 minutes, 50%) **Examination requirements:** Students show in the exam that they know the basics of seed marketing. In a scientific presentation they can demonstrate that they can apply this knowledge to current problems of the subject and are able to transfer their knowledge.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of marketing and market research (incl. statistics)
Language: English	**Person responsible for module:** Prof. Dr. Achim Spiller
Course frequency: every 4th semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 2 - 4
Maximum number of students: 30	

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:** Prof. Dr. Jens Tetens
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.0013: Selection theory, design and optimisation of breeding programs**	6 C 4 WLH

Learning outcome, core skills: Students are familiar with the theoretical basics of the selection theory even for complex cases (direct and correlated breeding progress, single- and multiple trait selection, multiple-path selection, gene flow method, optimum genetic contribution theory). Students are able to estimate the expected breeding progress for specific cases. They know the basic designs of breeding programs in plant and animal breeding and are able to model, calculate and optimize practical breeding programs by using suitable software programs.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Selection theory, design and optimisation of breeding programs (Lecture and Exercises) *Contents*: Introduction to the selection theory, direct and correlated breeding progress , single- and multiple trait selection , multi-path models , multiple-path selection, gene flow method, optimum genetic contribution theory; Explanation of typical breeding program structures in plant and animal breeding, principles of experimental design and optimal allocation of resources, introduction to breeding planning software (ZPLAN+, Genecont etc.), impact of selection on allele frequencies (Wright-model) and genetic variance (Bulmer effect), optimization of breeding programs under constraints (eg. conservation of genetic diversity). Literature: Walsh&Lynch: Evolution and Selection of Quantitative Traits	4 WLH
Examination: Written exam (45 minuntes, 50%) and presentation (about 20 minutes, 50%) **Examination requirements:** Profound knowledge of all aspects of the selection theory, application of methods for estimating the breeding progress, assessing the impact of different selection strategies to progress in breeding, inbreeding development and preservation of genetic variance.	6 C

Admission requirements: none	**Recommended previous knowledge:** Good knowledge of quantitative genetics and statistics
Language: English	**Person responsible for module:** Prof. Dr. Timothy Mathes Beissinger
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: Oral examination (approx. 20 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:** Dr. Mehmet Gültas
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:
Recommended previous knowledge: Basic knowledge of R	none
Language:	**Person responsible for module:**
English	Dr. Mehmet Gültas
Course frequency:	**Duration:**
each winter semester	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	
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:** Prof. Dr. Henner Simianer
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.0017: Applied Bioinformatics with R**	6 C 4 WLH

Learning outcome, core skills: This module will cover the fundamental concepts of bioinformatics. Topics will include usage of relevant/modern biological databases and tools that are required to perform different analyses. Further, an introduction to multi-omics-data will be given, including genome, trancriptome and proteome analysis. This module aims to teach interested students fundamental analysis skills to evaluate biological data using bioinformatic techniques, and to become proficient in performing such analyses. In more detail, following topics will be treated: • Analysis of multi-omics data • Standard databases in bioinformatics • DNA sequence and genome analysis • Variant calling techniques • Sequence alignment • Gene regulatory network analysis • Clustering The lecture will be based on the analysis of real data sets from agricultural research projects as far as possible.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Applied Bioinformatics with R (Lecture, Exercise) *Contents*: The course consists of lectures, exercises and a project work. After the lectures and the exercises the students will have to carry out a project work that must be finished within ten 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, 75%) and term paper (max. 10 pages, 25%) **Examination requirements:** • Knowledge about the fundamental concepts of bioinformatics • Knowledge about different databases in bioinformatics • Analysis of biological data, interpretation and modeling og biological information and applying this to the solution of biological problems in any area involving molecular data.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge of R
Language: English	**Person responsible for module:** Dr. Mehmet Gültas
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.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:** Dr. Mehmet Gültas
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	9 C
Module M.iPAB.0020: Breeding Lab Internship	

Learning outcome, core skills:	**Workload:**
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.	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. 30 minutes, 50%) with written report (max. 15 pages, 50%)	
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.	

Admission requirements: Only EMABG Students	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Henner Simianer
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.

Fakultät für Agrarwissenschaften:

Nach Beschluss des Fakultätsrats der Fakultät für Agrarwissenschaften vom 12.12.2019 hat das Präsidium der Georg-August-Universität am 21.01.2020 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).

Die Neufassung des Modulverzeichnisses tritt nach seiner Bekanntmachung in den Amtlichen Mitteilungen II zum 01.04.2020 in Kraft.

Directory of Modules

Master's degree programme "Crop Protection" - referring to: Prüfungs- und Studienordnung für den konsekutiven Master-Studiengang "Crop Protection" (Amtliche Mitteilungen I 36/2012 p. 1903, last revised through Amtliche Mitteilungen I 5/2020 108)

Modules

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Index by areas of study

I. Study programme "Crop Protection"

At least 120 C must be succesfully completed within the following regulations.

1. Professional studies

a. Compulsory Modules

The following compulsory modules worth overall 18 C must be successfully completed.

2. Professional knowledge

a. Elective compulsory modules

Elective compulsory modules worth at least 66 C must be successfully completed. Students can earn up to 18 C from elective modules from the other master study programmes of the faculty of agriculture, University of Goettingen. Furthermore, maximally one issue-specific module (at maximum worth 6 C) from another faculty can be chosen.

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b. Key competencies

Out of the following elective compulsory modules one module worth overall at least 6 C must be successfully completed.

3. Master's thesis

Completion of the Master's thesis is worth 24 Credits.

4. Colloquium for the Master's thesis

Successful completion of the colloquium for the Master's thesis is worth 6 Credits.

II. Double/Joint-Degree Programm "PlantHealth"

At least 120 C must be succesfully completed within the following regulations.

1. First year of study

At least 60 C must be succesfully completed within the following regulations.

a. Compulsory modules

The following compulsory modules worth overall 27 C must be successfully completed:

b. Elective compulsory modules

Out of the following elective compulsory modules four modules worth overall at least 27 C must be successfully completed.

c. Key competencies

Licit modules comprising at least 6 C must be passed.

2. Second year of study

At least 60 C must be succesfully completed within the following regulations.

a. Compulsory module

The following module comprising 6 C has to be passed.

b. Elective compulsory modules

Four of the following modules comprising 24 C have to be passed.

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c. Master's thesis

Completion of the Master's thesis is worth 24 Credits.

d. Colloquium for the Master's thesis

Successful completion of the colloquium for the Master's thesis is worth 6 Credits.

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: To acquire 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,agriculturalpolicy. To identify in detailcausalrelationships in the process management sugar on the basis of recent scientific knowledge. To intensify the knowledge by interpreting scientific figures and tables and their statistics. To gain from the unique opportunity of an advanced education particularly suitable as an on-the-job training program. To take the opportunity of social networking with not only other graduate students but external participants from different professional backgrounds and sugar beet growing countries worldwide, too.	**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 global trade, EU Reform of the Sugar Market Regime, systems for quota and paying, plant breeding, soil cultivation, growing impacts from sowing to harvest including all technical and cultivation aspects, crop yield, extensionservices, weed control, pathogen and pest management, as well as definition and analysis of the technical quality, processing technology of sugar beets, logistics of harvest and transportation, sugar as food and its marketing. The module consists of lectures by invited speakers and lecturers of the Institute of Sugar Beet Research, study and field trips.	
Examination: Oral examination (approx. 30 minutes) **Examination requirements:** M.Sc. after the 2nd semester or junior employees of supply chain. Knowledge of the sugar value chain and understanding of different influences to 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:** apl. Prof. Anne-Katrin Mahlein
Course frequency: each summer semester	**Duration:** 1 Week
Number of repeat examinations permitted:	**Recommended semester:**

twice	
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. Stefan Vidal
Course frequency: each winter semester; Göttingen	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 12	

Additional notes and regulations: Lecture based materials; details provided during lectures.

Georg-August-Universität Göttingen	6 C
Module M.Agr.0010: Biotechnological applications in plant breeding	4 WLH

Learning outcome, core skills:	Workload:
Students acquire theoretical and practical knowledge about fundamental plant biotechnological methods and their applications to contribute to solving actual problems in breeding of different crop species. Students learn to critically interpret scientific papers dealing with new biotechnological methods and applications.	Attendance time: 56 h Self-study time: 124 h

Course: Biotechnological Applications in Plant Breeding (Block course, Internship, Lecture, Seminar) *Contents*: Basics and principles of plant biotechnology and molecular genetics are examined and explained in lectures. Biotechnological applications in plant breeding and agriculture are presented and discussed in accompanying seminars given by the students. Topics covered include in vitro-techniques for the mass-propagation of plants, direct and indirect gene transfer in plants, biochemical and molecular characterization of transgenic plants, safety aspects of gene technological applications, haploid production and utilization in plant breeding, sexual and somatic interspecific hybridization, classical mutagenesis (TILLING), site directed mutagenesis, Polymerase chain reaction (PCR), molecular marker types (RAPD, RFLP, AFLP, SSR, SNP) and their genetic characteristics and applications in Plant Breeding. Experiments and Demonstrations underlining the theory will be performed in the greenhouse and in the laboratory.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Profound and complex theoretical knowledge about fundamental methods and their applications in plant breeding.	6 C

Admission requirements: none	Recommended previous knowledge: none
Language: English	Person responsible for module: Dr. Christian Möllers
Course frequency: each winter 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.0023: Interactions between Plants and Pathogens**	6 C 4 WLH

Learning outcome, core skills: Understanding interactions between plants and pathogens from general concepts to selected examples on phenomenological, morphological, physiological and molecular levels. Critical appraisal of technical approaches, supported by own practical experiences from the laboratory.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Interaktionen zwischen Pflanzen und phytopathogenen Organismen sowie Viren (Internship, Lecture) *Contents*: The course deals with interactions between host plants on one side and plant-pathogenic fungi, bacteria and viruses on the other side. The following topics are covered: Categorizatoin of inter-specific interactions among organisms; general concepts of pathogenicity, virulence and avirulence including gene-for-gene hypothesis and its experimental proof. Example of known resistance genes. Resistance factors (preformed and induced); counteracting mechanisms including detoxification. Induced local and systemic resistance. Infection of plants by *Agrobacterium tumefaciens* and inter-kingdom gene transfer. Disease cyclus of plant pathogenic fungi including host recognition, spore germination, penetration of plant surface, colonization of plant tissue, acquisition of nutrient, building biomass and dissemination of the pathogen. In the practical part of the course, participants will exctract phytoalexins from oilseed rape plants and learn chromatographic techniques for their detection and test their biological activity (HPLC-UV and TLC with bioautography detection).	4 WLH
Examination: Written examination (90 minutes) **Examination prerequisites:** Participation on the laboratory course and approval of the protocol **Examination requirements:** Understanding theoretical concepts treated in the lecture; knowlege of specific examples of pathosystems illustrating these concepts.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
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:**
Maximum number of students: 36	

Georg-August-Universität Göttingen	6 C
Module M.Agr.0039: Molecular Techniques in Phytopathology	4 WLH

Learning outcome, core skills:	**Workload:**
Technical skills in nucleic acid nucleic acid analysis techniques; ability to select adequat methods for a research project. Presentation and interpretation of the results.	Attendance time: 56 h Self-study time: 124 h

Course: Molecular Techniques in Phytopathology (Internship, Lecture)	4 WLH
Contents: With the help of laboratory experiments, basic molecular techniques will be taught, including the isolation of plasmids and total DNA as well es DNA fragments from electrophoretic agarose gels, cloning of PCR products (enzymatic modification, ligation), transformation and in vivo amplification of plasmids, DNA blotting, labeling of DNA probes for hybridization with nonradioactive labels (DIG-dUTP), Southern hybridization and detection of hybridized probes by chemiluminescence, ITS-RFLP-analysis of pathogens of oilseed rape, real-time PCR for mycotoxin-producing pathogens of cereals. In accompanying lectures, aspects of nucleic acid and protein chemistry relevant for analytical techniques will be explained. Technical solutions for specific scientific questions will be presented and discussed.	

Examination: Oral examination (approx. 30 minutes)	6 C
Examination prerequisites: Submitted and accepted protocol **Examination requirements:** Basic knowledge of the structure and properties of nucleic acids, properties and applications of enzymes used in the analysis and manipulation of DNA, understanding of standard techniques (Southern blotting, electrophoresis, DNA sequencing), data analysis, criteria for the selection of a DNA analytical technique for a specific task.	

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Birger Koopmann
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 16	

Georg-August-Universität Göttingen **Module M.Agr.0045: Mycology**	6 C 4 WLH

Learning outcome, core skills: • Learning methodology for handling of filamentous fungal organisms *in vitro* • Gaining knowledge on the phytopathogenic, mutualistic and ecological roles of filamentous fungi • Acquiring skills in the experimentation with phytopathogenic fungi on plants • Training in the taxonomic determination of fungal organisms	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Mycology (Internship, Lecture) *Contents*: • Overview on the ecology and taxonomy of phytopathogenic fungi • Exercises for the taxonomic determination of fungi based on morphology and molecular genetic analysis • Isolating of fungi from diverse habitats (soil, water, plants) • Inoculation of plants with phytopathogenic fungi and determination of disease severity • Determination of soil fungistasis • Race determination in powdery mildew • Assessment of fungicide resistance in fungi • in situ studies of infection by biotrophic and necrotrophic pathogens	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination prerequisites:** Preparation of experimental protocols (group work); presentation of results in a final seminar (group work); preparation of taxonomic sheets **Examination requirements:** Basic knowledge on the biology (life cycles, epidemiology) and ecology of filamentous fungi; specific knowledge on the gaining of fungal isolates from diverse habitats, their handling in the lab and their utilization in phytopathological experiments; basic steps in the taxonomic determination of fungi (conidiogenesis types); methods in fungal phytopathology; fungal diseases of crops (general knowledge)	6 C

Admission requirements: none	**Recommended previous knowledge:** Microbiology, plant pathology, crop protection
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: 1
Maximum number of students: 12	

Georg-August-Universität Göttingen **Module M.Agr.0056: Plant breeding methodology and genetic resources**	6 C 4 WLH

Learning outcome, core skills: Students learn the integration of classical and molecular approaches to solve present problems in plant breeding. Social aspects have to be considered. Students learn, in own presentations, to draw critical conclusions from recent research papers and to communicate these to other students.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Plant breeding methodology and genetic resources (Lecture) *Contents*: Principles of breeding methodology: Response to selection, breeding methods for clonal, line, hybrid and population cultivars. Marker assisted selection for monogenic and polygenic traits. Use of plant genetic resources: wild species, ex-situ and in-situ conservation, on-farm management. Breeding for marginal environments, demonstrated with examples from temperate and tropical regions.	4 WLH
Examination: Written exam (90 minutes, 80%) and presentation (approx. 20 minutes, 20%) **Examination requirements:** Population Genetics, Application of Markers in Plant Breeding, Concepts of using genetic resources in plant breeding. Good knowledge on: 'Pre-Breeding', categories and methods in Plant Breeding.	6 C

Admission requirements: none	**Recommended previous knowledge:** Basic knowledge (B.Sc. level) in genetics and plant breeding
Language: German, English	**Person responsible for module:** apl. Prof. Dr. Wolfgang Link
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 25	

Additional notes and regulations: **Literature:** Lecture based material.

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 homework (max. 20 pages, weighing 50%) **Examination prerequisites:** 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 **Module M.Agr.0058: Plant herbivore interactions**	6 C 4 WLH

Learning outcome, core skills: Knowledge of complex interactions between plants and herbivorous insects. Preparation and critical reflection of methods applied in current research findings covering the lecture topics by a seminar presentation.	**Workload:** Attendance time: 60 h Self-study time: 120 h

Course: Plant herbivore interactions (Lecture, Seminar) *Contents*: The modul deals with the interactions between plants and herbivorous insects. The diversiy of the organisms involved and the biocenoses are discussed. With regard to plants different adaptations to damage by insects are presented and the role of resistance mechanisms is outlined. The sensory organs of herbivorous insects to discriminate between different plant species and the role of volatile and secondary compounds produced by the plants are demonstrated. Multiple Interactions between plants, their herbivores, and natural enemies and application strategies in plant protection are discussed. The interactions between flowering plants and pollinators are outlined and the importance of seed predation will be exemplified. During the seminar part of the module students will present recent research findings which will complement the content of the lectures.	4 WLH
Examination: Written exam (67%, 45 minutes) and presentation (33%, approx. 20 minutes) **Examination prerequisites:** regular attendance at seminar and preparation of a seminar talk and a handout **Examination requirements:** Profound knowledge of processes involved in plant selection by herbivorous insects; protection strategies evolved by plants; determinants of herbivorous communities on specific plants, multitrophic interactions between plants; herbivorous insects and their natural enemies; interactions between plants and their pollinators or seed predators.	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	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Agr.0094: Basics of molecular biology in crop protection**	6 C 4 WLH

Learning outcome, core skills: Comprehension about important scientific plant pathogen detection methods like ELISA and PCR used in agriculture, knowledge about biochemical and molecular basics in plant breeding and genetic resistance against plant pathogens.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Basics of molecular biology in crop protection (Lecture) *Contents*: In agricultural research and diagnostics there is an increasing use of biochemical and molecular methods and techniques. The lecture conveys the scientific basics that are required for the understanding of these methods and prepares students for further practical courses and lectures. Specific contents are: cytology, cell-wall composition of different organisms, structure and function of different macromolecules (proteins, DNA, carbohydrates), function and regulation of enzymes, DNA-replication, transcription and translation, mechanisms of regulation, intruduction into principles of molecular detection methods, lipids and membranes, phytohormones and selected secondary metabolites.	4 WLH
Examination: Written examination (90 minutes) **Examination prerequisites:** Präsentation (ca. 10 Min.) **Examination requirements:** Composition of macromolecules, output materials, typical molecular binding types, function, regulatory mechanisms on protein and nucleic acid level, phytohormones, secondary metabolism.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Mark Varrelmann
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	3 C
Module M.Agr.0146: Nematology	4 WLH

Learning outcome, core skills:	Workload:
Basic knowledge of the nematode bauplan, their role as pests; basic methods with regard to the quantification and control of nematodes, importance and application of nematodes in biological control programs; their role in regulation processes in ecosystems. Seminar talk on a specific scientific problem related to nematodes.	Attendance time: 60 h Self-study time: 30 h

Course: Nematology (Internship, Seminar)	4 WLH
Contents: The module deals with the biology of nematodes and their importance in plant protection. The most important taxa of nematodes are presented by preparations and living organisms; the most important morphological characters will be identified. Interactions between plant parasitic nematodes and their hos plants will be discussed. The role of nematodes in innundative biological control measures will be discussed as well. During the course students will become familiar with des different nematode species and will learn basic principles of their determination. Phytoparasitic nematodes will be prepared. A practical experiment will demonstrate toxicity of different compounds.	
Examination: Term Paper (max. 30 pages) **Examination prerequisites:** Regular attendance during the course; preparation of a protocol containing own drawings **Examination requirements:** Basic knowledge in morphological characters of nematodes; ability to discriminate between different feeding types of nematodes; role and function of biological control using nematodes; importance of nematodes for biodiversity; in some circumstances preparation of homework.	3 C

Admission requirements:	Recommended previous knowledge:
none	none
Language: English	**Person responsible for module:** Prof. Dr. Stefan Vidal
Course frequency: each winter semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 12	

Georg-August-Universität Göttingen **Module M.Cp.0002: Internship**	9 C 6 WLH

Learning outcome, core skills: Specific knowledge of the respective area of work/research will be acquired, social abilities and competences like work organization, teamwork, interdisciplinary work, flexibility will be acquired.	**Workload:** Attendance time: 240 h Self-study time: 30 h

Course: Internship (Internship) *Contents*: Students will carry out a practical project in different areas of crop protection, in agrochemical companies, in research or consulting institutions and experience the daily work situation. They will work on other projects and experience the daily working routine outside the university. Duration minimum 6 weeks.	6 WLH
Examination: Written paper (max. 20 pages, 50%) and Presentation (ca. 20 minutes,50%) **Examination requirements:** Practial work in a scientific project in different areas of crop protection, written internship report and seminar presentation.	9 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:** Master: 3
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Cp.0004: Plant diseases and pests in temperate climate zones**	6 C 4 WLH

Learning outcome, core skills:	Workload:
Students will be able to recognize and identify the main pests and diseases, understand the origin, distribution and dynamics of diseases and pests in the field as a basis for the development of control methods.	Attendance time: 56 h Self-study time: 124 h

Course: Plant Diseases and Pests in Temperate Climate Zones (Lecture, Excursion, Exercise) *Contents*: The main diseases and pests (fungi, viruses, bacteria, nematodes, mites, and insects) of crops (arable crops, vegetables, fruit crops) in temperate climate zones will be presented. The symptoms, diagnosis, biology and life cycles, economic importance, possible control methods will be studied in lectures, practicals and field trips. The economic damage, prognosis, possible control methods using economic thresholds will be presented.	4 WLH
Examination: Written examination (45 minutes) **Examination prerequisites:** regular attendance at field practical and excursion **Examination requirements:** Identification and diagnosis of plant pests and diseases of crops of the temperate climate zones, knowledge of the life cycle, distribution, and population dynamics.	6 C

Admission requirements:	Recommended previous knowledge:
Only for students in the study programmes "Crop Protection", EMJMD PlantHealth and "Sustainable international Agriculture".	none
Language: English	**Person responsible for module:** Dr. Birger Koopmann
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Cp.0005: Integrated management of pests and diseases**	6 C 4 WLH

Learning outcome, core skills: Students will be able to understand and develop plant protection strategies to control plant pathogens and insect pests while observing the sustainability of the whole crop production system.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Integrated Management of Pests and Diseases (Lecture) *Contents*: The integrated pest management concept and its main components are presented with regard to the management of fungal plant pathogens and insect pests in temperate zones: preventive methods, selective use pesticides, effect of cultural methods (sowing date, soil preparation, fertilization, crop rotation, varieties) on occurrence, distribution and damage of plant pathogens and insect pests.The diagnostics and quantification of damage symptoms; prognosis systems are discussed.	4 WLH
Examination: Oral examination (approx. 20 minutes) **Examination requirements:** Knowledge of the relationship between crop production methods and the occurrence of plant diseases and insect pests in temperate zones, concept of integrated pest management.	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: 1
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Cp.0006: Pesticides I: Mode of action and application techniques, resistance to pesticides**	6 C 4 WLH

Learning outcome, core skills:	Workload:
Students will know the pesticide compounds used in agriculture, their mode of action, application techniques and understand the development of resistance and resistance management strategies.	Attendance time: 56 h Self-study time: 124 h

Course: Pesticides I: Mode of Action and Application Techniques, Resistance to Pesticides (Lecture, Excursion) *Contents*: Mode of action and application techniques of plant protection products (fungicides, insecticides, acaricides, herbicides), the characeristics of active ingredients are presented. Technical and technological possibilities of modern crop protection, requirements and pesticide resistance management is discussed.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Knowledge of pesticides, their mode of action, targets, side effects, application techniques; important factors for resistance development and possibilities for prevention and reduction.	6 C

Admission requirements: Only for students from the study programme "Crop Protection" and "Sustainable International Agriculture"	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: 1
Maximum number of students: 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	6 C
Module M.Cp.0008: Fungal toxins	4 WLH

Learning outcome, core skills:	**Workload:**
Students will realize the importance of secondary metabolites produced by fungi in plant production. They will be able to compare and rate the significance of natural toxins and anthropogenic substances and to classify different food contaminations according to their toxicology	Attendance time: 56 h
In the laboratory students will acquire practical knowledge of chemical- analytical methods, so they will be able to select the optimum analytical method.	Self-study time: 124 h

Course: Fungal Toxins (Lecture, Practical course)	4 WLH
Contents:	
The most important mycotoxins will be presented and described, concepts to determine the toxicity and procedures to develop legal maximum values will be discussed, and the risk for consumers and animals will be judged. The ecological importance of mycotoxins will be discussed, methods of mycotoxin identification will be explained and methods to reduce the mycotoxin contents of plant products will be presented.	
Selected phytoalexins and phytohormons playing a role as a factor of virulence or pathogenecity in plant diseases will be introduced.	
In the practical students will process plant material and use different methods for analysis of mycotoxins.	

Examination: Written examination (60 minutes)	6 C
Examination prerequisites:	
Accepted laboratory protocol	
Examination requirements:	
Knowledge of the most important mycotoxins occuring in crop plants, methods to analyse their toxicity, development of legal limit values; ecological importance of mycotoxins; methods to determine mycotoxins, factors responsible for mycotoxin content in plant products, the importance of phytotoxins and phytohormones as facrors of virulence and pathogenicity.	

Admission requirements:	**Recommended previous knowledge:**
none	none
Language:	**Person responsible for module:**
English	Prof. Dr. Petr Karlovsky
Course frequency:	**Duration:**
each winter semester	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	
Maximum number of students:	
12	

| **Georg-August-Universität Göttingen** | 3 C |
| **Module M.Cp.0010: Plant Pathology and Plant Protection seminar** | 2 WLH |

| **Learning outcome, core skills:** | **Workload:** |
| Students will learn, to present, discuss and defend their own individual research project. They will be able to critically discuss scientific results and provide suggestions for improvement. | Attendance time: 28 h Self-study time: 62 h |

| **Course: Plant Pathology and Plant Protection Seminar** (Seminar) | 2 WLH |
| *Contents*: In this seminar scientific projects, targets of research and results of research projects will be presented and discussed by the MSc students and members of the research staff. Techniques of presentation and the ability to critically review and discuss research results will be practiced which will suggest and lead to new thoughts for further research projects. *Course frequency:* each winter semester | |

| **Examination: Presentation (ca. 20 minutes)** **Examination prerequisites:** Participation in 12 seminars **Examination requirements:** Very good knowledge of own area of research and good ways of presentation of own results. Participation in discussion. | 3 C |

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Birger Koopmann
Course frequency: each semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Cp.0011: Agricultural entomology seminar**	3 C 2 WLH

Learning outcome, core skills: Students will learn, to present, discuss and defend their own individual research project. They will be able to critically discuss scientific results and provide suggestions for improvement.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Agricultural Entomology Seminar (Seminar) *Contents*: In this seminar scientific projects, targets of research and results of research projects in Agricultural Entomology will be presented and discussed by the MSc students. Techniques of presentation and the ability to critically review and discuss research results will be practiced which will suggest and lead to new thoughts for further research projects.	2 WLH
Examination: Presentation (ca. 20 minutes) **Examination prerequisites:** Participation in 12 seminars **Examination requirements:** Very good knowledge of own area of research and good ways of presentation of own results. Participation in discussion.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Michael Georg Rostás
Course frequency: each semester	**Duration:** 2 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Cp.0012: Weed biology and weed management**	6 C 4 WLH

Learning outcome, core skills: Students will understand the biology of local and worldwide important weeds, their taxonomy, life-form and habitat requirement, as well as their evolution, distribution, plant sociology, ecology, population dynamics and genetics. Endangered as well as invasive species, the interaction of weeds and crops (allelopathy and competition), weed control with direct (chemical and mechanical), and indirect (agronomic) measures will be taught.	**Workload:** Attendance time: 60 h Self-study time: 120 h

Course: Weed Biology and Weed Management (Lecture) *Contents*: In the lecture the three main topics in Weed Science, the biology of weeds, the interaction of weeds and crops, and the weed management with direct (chemical and mechanical) and indirect (agronomic) measures will be presented. The benefits and harms of weeds for the ecology, society and the economy will be discussed. The need for species conservation vs. weed control is discussed in the context of the efficacy of weed control measures. Project work: Students will work on a project in teams. They will cultivate weeds and crops in the greenhouse and investigate the weed crop interaction in competition experiments.	4 WLH
Examination: Written examination (90 minutes) **Examination requirements:** Basic knowledge of weed characteristics, biology and ecology. Knowledge of the main weed control techniques, mode of action and examples. Knowledge of the main weeds worldwide and ways of management. Ability to associate weed populations with present crop production systems and develop control strategies.	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:** Master: 1
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Cp.0014: Plant Nutrition and Plant Health**	3 C 2 WLH

Learning outcome, core skills: Understanding the relationship between plant nutrition and plant health and its significance in the value-added food chain.	**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 exam (90 minutes) **Examination requirements:** 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.	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 management 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 importance in the development of new herbicides and will be discussed as well as alternative transgenic approaches in weed management. Practical: A one week practical will be held after the lecture. 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:** Regular participation in the laboratory practical **Examination requirements:** Knowledge of the interaction between herbicide and target, the selectivity of herbicides, mechanisms of resistance in weeds, mechanisms of development of tolerance in cultivated plants. Basic knowledge of development and distribution of herbicide resistance in weeds	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Dr. Jean Wagner
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.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:** Master: 2
Maximum number of students: 30	

Georg-August-Universität Göttingen **Module M.Cp.0017: Scientific presenting, writing and publishing in crop protection**	3 C 2 WLH

Learning outcome, core skills: Students are expected to be able to write scientific papers in English, to design graphics and tables, conduct a literature recherche, to prepare oral and poster presentations, to review manuscripts. Students know the process of paper publication, from writing to submitting and reviewing.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Scientific Presenting, Writing and Publishing in Crop Protection (Lecture, Seminar) *Contents*: Students will prepare a written paper dealing with selected topics in crop protection. The "Good Scientific Practice", the structure and design of scientific papers, preparation and submission of a manuscript for publication, design of scientific presentations (structure, way of presentation, rhetorics) will be presented.	2 WLH
Examination: Term Paper (max. 10 pages) **Examination prerequisites:** regular attendance at seminar **Examination requirements:** Ability to search literature and compile a paper dealing with a scientific topic in crop protection.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Andreas von Tiedemann
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 2
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Cp.0018: Journal club on new topics in crop protection**	3 C 2 WLH

Learning outcome, core skills: Students learn how to assess and discuss a scientific subject in crop protection: They will be able to give written and oral presentations of a scientific paper and to critically judge the didactic, structure and scientific content and correctness of a scientific paper.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Journal Club on New Topics in Crop Protection (Lecture, Seminar) *Contents*: Methods will be presented how to collect and read scientific literature dealing with a specific topic. The composition and structure of scientific publications, methods and ways of presentation and proving ideas are studied using specific examples. Criteria for quality assessment are applied.	2 WLH
Examination: Presenation (ca. 15 minutes) and written paper (3 pages) **Examination prerequisites:** Participation in the seminars **Examination requirements:** Preparation of written review of a scientific paper, which will be presented and discussed in the seminar.	3 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Andreas von Tiedemann
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:** Master: 2
Maximum number of students: 20	

Georg-August-Universität Göttingen **Module M.Cp.0019: Basic laboratory techniques**	3 C 2 WLH

Learning outcome, core skills: Students will get prepared for practical research, including basic chemical and microbiological techniques as well as responsible behaviour in the laboratory and operating of machines.	**Workload:** Attendance time: 28 h Self-study time: 62 h

Course: Basic Laboratory Techniques (Internship) *Contents*: The practical includes laboratory safety, planning and recording of experiments, chemical calculations (concentrations in media and buffer), sterilization techniques, working in sterile conditions, pH, photometry, ELISA, PCR, preparation of experiments and writing protocols. Students learn to plan and execute safely experiments, to explain and use methods and equipment effectively.	2 WLH
Examination: Written examination (45 minutes) **Examination prerequisites:** Accepted protocol **Examination requirements:** Basic knowledge of calculation of concentrations, sterilization techniques, importance and composition of buffers, principles of photometry, centrifugation, ELISA and PCR.	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:** Knowledge of ecotoxicological testing methods and their evaluation for the risk assessment of plant protection products.	3 C

Admission requirements: Plant Health/Crop Protection	**Recommended previous knowledge:** none

Language:	Person responsible for module:
English	Prof. Dr. Lennart Weltje
Course frequency:	**Duration:**
each winter semester	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	
Maximum number of students:	
15	

Georg-August-Universität Göttingen **Module M.Cp.0021: Plant Health Internship**	6 C

Learning outcome, core skills: Specific knowledge of the respective area of work/research will be acquired, social abilities like work organization, teamwork, interdisciplinary work, flexibility will be practiced	**Workload:** Attendance time: 20 h Self-study time: 160 h

Course: Plant Health Internship *Contents*: Students will carry out practical work in areas of crop protection, in agrochemical companies, in research or consulting institutions and experience the daily work situation Duration: approx. 4 weeks	4 WLH
Examination: Term Paper (max. 20 pages) **Examination requirements:** Practial work in a scientific project in different areas of crop protection, written internship report showing that students gathered knowledge of their research topic, its relevance, are able to evaluate data, explain and interpret them in a written document.	6 C

Admission requirements: none	**Recommended previous knowledge:** none
Language: English	**Person responsible for module:** Prof. Dr. Andreas von Tiedemann
Course frequency: each summer semester	**Duration:** 1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 8	

Georg-August-Universität Göttingen	6 C
Universität Kassel/Witzenhausen	4 WLH
Module M.SIA.E13M: Microeconomic theory and quantitative methods of agricultural production	

Learning outcome, core skills:	Workload:
Microeconomic Theory of Agricultural Production	Attendance time:
Students are familiar with microeconomic approaches and can apply them to analyze issues related to agriculture and rural development.	56 h
	Self-study time:
Quantitative Methods in Agricultural Business Economics	124 h
Students are familiar with quantitative methods used for the analysis and planning of farms and enterprises in the agricultural sector.	

Course: Microeconomic theory of agricultural production (Lecture)	2 WLH
Contents: Consumer theory, producer theory, markets, monopoly situations, risk and uncertainty, economics of technical change, farm household models, sharecropping contracts.	

Course: Quantitative methods in agricultural business economics (Lecture)	2 WLH
Contents: Budgeting, accounting, annual balance sheets, linear programming, finance, investment analysis	

Examination: Written examination (120 minutes)	6 C
Examination requirements: Consumer theory; producer theory; risk; technological progress; farm household models; budgeting and accounting; linear programming; finance; investment analysis	

Admission requirements:	Recommended previous knowledge:
none	none
Language:	**Person responsible for module:**
English	Prof. Dr. Matin Qaim
Course frequency:	**Duration:**
each winter semester; Göttingen	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	
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	6 C
Universität Kassel/Witzenhausen	4 WLH
Module M.SIA.P07: Soil and plant science	

Learning outcome, core skills:	**Workload:**
Bridging module for students lacking basic knowledge in some agronomy disciplines. With the help of lectures and reading materials students will be enabled to fill in gaps and get updated on state-of-the art knowledge with a special focus on questions pertinent to organic agriculture. Students, having taken this module, will be able to follow advanced courses in the above fields.	Attendance time: 60 h Self-study time: 120 h

Course: Soil and plant science (Lecture, Seminar)	4 WLH
Contents: Influence of soil formationprocesses on physical properties (texture, soil water, pore space), chemical properties (buffering, exchange capacity, nutrients), and biological properties (organic matter, edaphon), soil formation and classification. Nutrient availability and and nutrient mobilization under conventional and organic agricultural conditions. Major and minor nutrients and food quality.Plant breeding goals for different agricultural systems. Plant morphology, genetics and breeding: principles of plant domestication and use, characterization and evaluation, use of genetic resources in plant breeding, genetic basis for plant breeding Genetics of host-parasite interactions, epidemiology and plant defence. Insect physiology and ecology.	
Spezifische allgemeine und wissenschaftliche Artikel, die sich mit dem Zielland der Exkursion befassen werden über eine E-Learning Plattform zur Verfügung gestellt	

Examination: Written exam (120 minutes) or oral exam (ca. 20 minutes) **Examination requirements:**	6 C
Fundamentals of soil science: Physical properties (texture, soil water, pore space), chemical properties (buffering, exchange capacity, nutrients), biological properties (organic matter, edaphon), soil formation and classification.	
Plant nutrition: Role of major and minor elements in plants, nutrient availability and nutrient mobilisation, plant nutrients and food quality	
Plant breeding and genetics: plant morphology, genetics and breeding: principles of plant domestication and use, characterization and evaluation, use of genetic resources in plant breeding, genetic basis for plant breeding.	
Plant protection: principles of plant pathology and entomology, genetics of plant diseases, epidemiology, plant defence mechanisms; insect physiology and ecology	

Admission requirements:	**Recommended previous knowledge:**
none	none
Language:	**Person responsible for module:**
English	Dr. Helmut Saucke
Course frequency:	**Duration:**

each winter semester; Witzenhausen	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: not limited	

Additional notes and regulations:

Literature:

Brady, N.C. 1990: The nature and properties of soils. 10th edition, Prentice Hall; Marschner, H. 1995: Mineral Nutrition of Higher Plants, Academic Press, New York; Sanchez, P. 1976: Properties and Management of Soils of the Tropics, Wiley, New York; van Wyk, B.E. 2005: Food Plants of the World. Briza Publication, Pretoria; Rehm, S., Espig, G. 1991: The Cultivated Plants of the Tropics and Subtropics. Verlag Josef Margraf, Weikersheim, Germany; Agrios, G.N. 2005: Plant Pathology, 5th edition, Academic Press, New York; Pedigo, L.P. 2002: Entomology and Pest Management, 4th edition, Macmillan Pub Co.

Georg-August-Universität Göttingen	6 C
Universität Kassel/Witzenhausen	6 WLH
Module M.SIA.P08: Pests and diseases of tropical crops	

Learning outcome, core skills:	Workload:
Students should become familiar with the causes of diseases (abiotic & biotic diseases), with the taxonomy of disease agents (bacteria, fungi, virus) and insect pests, with basics of integrated pest management (approaches, economic threshold, epidemiology), and biological, cultural control (cultivars, crop rotation, planting term, manual control), and chemical control options (toxicology, fungicides, insecticides) of the main crops in subtropical and tropical regions	Attendance time: 84 h Self-study time: 96 h

Course: Pests and diseases of tropical crops (Lecture, Seminar)	6 WLH
Contents: Pests and diseases of selected crops are treated together for each crop including approaches to integrated control. The following crops will be presented: rice, maize, cotton, cocoa, coffee, cassava, phaseolus beans, bananas, and others. For each crop, a short introduction to botanical and agronomic features (as far as they concern disease or pest control) is given, together with an overview of the main diseases world-wide. The economic importance of diseases and pests in different geographical areas is discussed. The most important diseases and pests of die crop are treated in detail and die possibilities for integrated control are discussed. Short introductions (reviews) on basic subjects of plant protection are given, these include: causes of diseases (abiotic & biotic diseases), taxonomy of disease agents (bacteria, fungi, viruses) and insect pests, integrated pest management (approaches, economic threshold), biological control (diseases, pests), cultural control (varieties, crop rotation, planting term, manual control), and chemical control (toxicology, fungicides, insecticides). Students will give seminars on related topics. Vorlesungsbasierte Literatur	
Examination: Written exam (60 minutes, 67%) and presentation (ca. 20 minutes, 33%) **Examination prerequisites:** Seminar speech **Examination requirements:** Knowledge on the most important pests and diseases of tropical and subtropical crops; chemical and biological control options, phytosanitary approaches, and sustainable cropping systems for tropical crops.	6 C

Admission requirements:	Recommended previous knowledge:
none	Basic knowledge (B.Sc. level) in agricultural entomology, plant diseases and plant production
Language: English	**Person responsible for module:** Prof. Dr. Stefan Vidal
Course frequency:	**Duration:**

each summer semester; Göttingen	1 semester[s]
Number of repeat examinations permitted: twice	**Recommended semester:**
Maximum number of students: 30	

Additional notes and regulations: **Literature:**   Lecture based materials; details provided during lectures.

Georg-August-Universität Göttingen	6 C
Universität Kassel/Witzenhausen	4 WLH
Module M.SIA.P15M: Methods and advances in plant protection	

Learning outcome, core skills:	Workload:
Students are able to critically evaluate published results and apply this knowledge to actual problems in the field. They are also able to deal with problems in the field: Identification and measurements, design of experimental and analytical approaches to problems.	Attendance time: 60 h Self-study time: 120 h

Course: Methods and advances in plant protection (Lecture, Excursion, Exercise)	4 WLH
Contents: Advanced course in plant pathology and entomology. Methodology and evaluation methods in plant protection. Case studies of specific plant protection issues in organic farming in the form of lectures, seminars and practical courses.	

Examination: Written exam (120 minutes) or oral exam (ca. 20 minutes) (70%) and work reports (max. 3 pages) or seminar speech (ca. 10 minutes) (30%) Examination requirements: Advanced knowledge in plant protection (Entomology and Pathology) Methodology and evaluation methods in plant protection based on case studies.	6 C

Admission requirements:	Recommended previous knowledge:
Introductory course in plant protection (entomology and pathology, at least 6 ECTS or equivalent) or bridging module M.SIA.P07 Soil and Plant Science	none
Language: English	**Person responsible for module:** Prof. Dr. Maria Renate Finckh
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:
Agrios, G.N. 2005: Plant Pathology, 5th edition Academic Press, New York; Pedigo, L.P. 2002: Entomology and Pest Management, 4th edition, Macmillen Pub Co.

Georg-August-Universität Göttingen	6 C
Universität Kassel/Witzenhausen	4 WLH
Module M.SIA.P22: Management of tropical plant production systems	

Learning outcome, core skills:	Workload:
Knowledge of botanical, ecological and agronomic facts of presented crops and cropping systems. The students should be able to classify crops and cropping systems in relation to site conditions and undertake system-orientated evaluation of sustainable production.	Attendance time: 60 h Self-study time: 120 h

Course: Management of tropical plant production systems (Lecture)	4 WLH
Contents: Presentation of the most important crops with respect to: botany, morphology, origin, climatic and ecological requirements, crop production, harvest procedure, significance in local farming systems, utilisation as food, feed, raw materials and as bioenergy source. Discussion of specific cropping systems in the tropics and subtropics and specific management systems for the sustainable improvement of productivity. **Literatur** Rehm, S., Espig, G. 1991: The Cultivated Plants of the Tropics and Subtropics. Verlag Josef Margraf. Weikersheim, Germany; lecture notes	

Examination: Written exam (90 minutes) or oral exam (ca. 30 minutes) Examination requirements:	6 C
Knowledge of botanical, ecological and agronomic facts of the presented crops and cropping systems. Knowledge of the assignment of crops and cropping systems to different site conditions, as well as system-oriented evaluation of sustainable production at selected sites.	

Admission requirements:	Recommended previous knowledge:
none	Basic knowledge on plant production (BSc-level)
Language:	**Person responsible for module:**
English	Prof. Dr. Reimund P. Rötter
Course frequency:	**Duration:**
each winter semester; Göttingen	1 semester[s]
Number of repeat examinations permitted:	**Recommended semester:**
twice	
Maximum number of students:	
30	

Additional notes and regulations:
exam on the first examination, oral exam on the second examination
Literature:

Rehm, S., Espig, G. 1991: The Cultivated Plants of the Tropics and Subtropics. Verlag Josef Margraf. Weikersheim, Germany; lecture notes

Georg-August-Universität Göttingen **Module M.WIWI-QMW.0004: Econometrics I**	6 C 6 WLH

Learning outcome, core skills: This lecture provides a detailed introduction and discussion to the theory of several topics of econometrics. In a practical course the students will apply the methods discussed to real economic data and problems using the statistical software packages Eviews and R.	**Workload:** Attendance time: 56 h Self-study time: 124 h

Course: Econometrics I (Lecture) *Contents*: Multiple linear regression model: Estimation, Inference and Asymptotics. Maximum likelihood modeling. Generalized least squares. Stochastic regressors. Intrumental variable estimators. Generalized method of moments, likelihood based inference. Dynamic models, weak exogeneity, cointegration, stochastic integration. **Literature:** Wooldridge, Jeffrey M. 2006. *Introductory econometrics: a modern approach*. Mason, OH: Thomson/South-Western; Chapters 1, 2, 3, 4, 5, 6, 8. Verbeek, Marno. 2008. *A guide to modern econometrics*. Chichester, England: John Wiley & Sons; Chapters 1-4, 6. Judge et al. 1988. Introduction to the theory and practice of econometrics. Wiley, 2nd edition.	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: Linear regression models, generalized linear regression models. OLS, GLS, EGLS estimation. Multiplikative heteroskedasticity, autocorrelation. LM specification testing, Durbin Watson test. Convergence in probability, convergence in distribution. Asymptotics (consistency, asymptotic normality) of OLS estimators. IV estimation, GMM estimation.	

Admission requirements:	**Recommended previous knowledge:**

none	Notwendige: Mathematik (lineare Algebra), Statistik. Erwünscht: Einführung in die Ökonometrie (oder vergleichbare Vorlesung)
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	