Module Catalog

M.Sc. Agrosystem Sciences
TUM School of Life Sciences
Technische Universität München

www.tum.de/
www.ls.tum.de/ls/startseite/

Module Catalog: General Information and Notes to the Reader

What is the module catalog?
One of the central components of the Bologna Process consists in the modularization of university curricula, that is, the transition of universities away from earlier seminar/lecture systems to a modular system in which thematically-related courses are bundled together into blocks, or modules.
This module catalog contains descriptions of all modules offered in the course of study.
Serving the goal of transparency in higher education, it provides students, potential students and other internal and external parties with information on the content of individual modules, the goals of academic qualification targeted in each module, as well as their qualitative and quantitative requirements.

Notes to the reader:

Updated Information
An updated module catalog reflecting the current status of module contents and requirements is published every semester. The date on which the module catalog was generated in TUMonline is printed in the footer.

Non-binding Information
Module descriptions serve to increase transparency and improve student orientation with respect to course offerings. They are not legally-binding. Individual modifications of described contents may occur in praxis.
Legally-binding information on all questions concerning the study program and examinations can be found in the subject-specific academic and examination regulations (FPSO) of individual programs, as well as in the general academic and examination regulations of TUM (APSO).

Elective modules
Please note that generally not all elective modules offered within the study program are listed in the module catalog.

Index of module handbook descriptions (SPO tree)

Alphabetical index can be found on page 330

Required Modules | Pflichtmodule

Module Description

WZ0028: Applied Statistics: Biometrics and Econometrics | Angewandte Statistik: Biometrie und Ökonometrie

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird schriftlich in Form einer 120-minütigen Klausur erbracht. In dieser weisen die Studierenden nach, dass sie die Zusammenhänge von Versuchsfrage, Versuchsdesign und statistischer Auswertung verstanden haben und geeignete ökonometrische oder biometrische Modelle auf spezifische Fragestellungen anwenden können. Dabei erhalten die Prüflinge zu praxisnahen Fallbeispielen aus den Agrarwissenschaften, die die systemaren Zusammenhänge verdeutlichen, Versuchsdaten, Zwischenergebnisse oder Computeroutputs zur Verfügung, an Hand derer Sie passende Modelle auswählen, um Hypothesen zu testen und das Ergebnis zu interpretieren. Als Hilfsmittel ist ein Taschenrechner zugelassen. Zur Beantwortung der Fragen sind eigene Berechnungen und Formulierungen erforderlich.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Einführung in die Statistik, Angewandte Statistik (Bacheolor)

Content:
In diesem Modul wird der Zusammenhang zwischen dem Versuchsdesign und der Verwendung statistischer Problemlösungsmodelle behandelt. An Hand unterschiedlicher Anlagemethoden und Datenermittlungen wird erarbeitet welche biometrischen oder ökonometrischen Problemlösungsmodelle ausgewählt werden können, um eine Antwort auf die Versuchsfrage zu erhalten. Die Studierenden werden dabei ausgehend von der Versuchsfrage Hypothesen aufstellen, eine Anlagemethode erstellen, die Versuchsergebnisse mit der Statistiksoftware Stata auswerten und die Computeroutputs interpretieren.

Die Lehrveranstaltungen (Vorlesungen und Übungen) haben folgende Inhalte:
1. Einführung in die Methodik des FeldversuchsBiometrische Versuchsplanung und Anlagemethoden
2. Versuchsanlage und biometrische Auswertung
2.1 Beschreibende Statistik
2.2 Testen von Hypothesen
2.3 Ein- und mehrfaktorielle Varianzanalyse mit fixen, zufälligen und gemischten Effekten
2.4 Multiple Mittelwertsvergleiche
2.5 Da tentransformation
2.6 Nicht parametrische Statistik
3. Einführung in die Methodik der Ökonometrie
4. Endogenität
5. Lineares und Multiples Regressionsmodell
5.1 F-Test und korrigiertes Bestimmtheitsmaß
5.2 Dummyvariablen
5.3 Fixe und zufällige Effekte
6. Instrumentenvariablen
7. Daten- und Variablentypen
8. Hypothesentest
9. Interpretation

Intended Learning Outcomes:
Nach dem erfolgreichen Besuch des Moduls sind die Studierenden in der Lage, die theoretischen Grundlagen ökonometrischer und biometrischer Verfahren zu erläutern, verschiedene Datenstrukturen zu unterschieden und für eine spezifische Fagestellung das geeignete ökonometrische oder biometrische Modell auszuwählen. Insbesondere können die Studierenden
(1) statistische Problemlösungsmodelle benennen mit deren Hilfe eine Versuchsfrage bearbeitet werden kann,
(2) eine Hypothese formulieren und in ein Versuchsdesign umsetzen,
(3) den Unterschied zwischen Exaktversuchen und Beobachtungsversuchen verstehen,
(4) die Hypothese durch die Auswahl von statistischen Modellen, orientiert am Versuchsdesign testen,
(5) die Testergebnisse korrekt interpretieren,
(6) ein Ergebnis für den Versuchsbericht formulieren.

Teaching and Learning Methods:
Vorlesung mit Wiederholungskomponente am Anfang zur Aktivierung von Vorwissen, Präsentationen und Tafelarbeit zur Wissensvermittlung sowie Gruppenarbeit zur Verarbeitung des Stoffes; Übung mit Aufgaben am PC zur Vermittlung der praktischen Umsetzung theoretischer Inhalte mittels der Statistiksoftware "R"; Hausaufgaben zur Vertiefung erlernten Wissens und zur Einübung statistischer Analysemethoden.

Media:
Präsentation mittels Powerpoint, Tafelarbeit, Computerarbeit mit Statistiksoftware, Übungsblätter mit Hausaufgaben.

Reading List:
Erhard, Thomas, 2006: Feldversuchswesen, Ulmer, UTB ISBN 3-8252-8319-4
Angrist, Joshua, D., Pischke, Jörn-Steffen, 2015: Mastering Metrics, Princeton University Press, ISBN 9780691152844

Responsible for Module:
Amon, Harald; Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Biometrie (Vorlesung) (Vorlesung, 1 SWS)
Amon H [L], Amon H

Biometrie (Übung) (Übung, 1 SWS)
Amon H [L], Amon H

Ökonometrie (Vorlesung) (WZ0028, deutsch) (Vorlesung, 1 SWS)
Sauer J [L], Frick F

Ökonometrie (Übung) (WZ0028, deutsch) (Übung, 1 SWS)
Sauer J [L], Schlereth N
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0031: Research Practical | Forschungsprojekt

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is carried out in the form of a project work. This consists of a poster, a poster presentation and a more detailed written paper (weighting for grading: 25% poster, 25% poster presentation, 50% report). On the poster, the student's own conception of the research project and the results achieved are presented, evaluated and discussed in a suitable visualisation. During the poster presentation of 5-10 minutes the student answers questions (10-15 minutes) about his/her research project. In this way, in addition to the ability of visual presentation, the communicative competence in the oral presentation of scientific topics in front of an audience is tested and provided with feedback. The student demonstrates that he/she is also able to respond competently to questions, suggestions and discussion points from the audience in the respective topic area. The accompanying written elaboration consists of a protocol of no more than 10 pages, which documents the conception, the course of the research activity, the methodology used and the data obtained, since the poster and the presentation reflect these aspects only in a shortened form.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basics in crop science at B.Sc. level

Content:
First of all, students are introduced to the scientific theoretical basics. They are given an overview of research funding and publications and the guidelines for ensuring good scientific practice are explained. Students will be trained in the use of visualisation possibilities and in poster production in theory and practical exercises. The methodology of project plan creation is practiced using examples. This will then be applied individually by each student to their own project topic under the guidance of the concept development.

The student will then work on this current research topic in agricultural sciences, which he/she has chosen in large parts.

Intended Learning Outcomes:
After successful completion of the module, the student is able to carry out a research activity on a scientific problem from the agricultural sciences conceptually and experimentally largely independently. He/she is able to analyse and evaluate the available methodology based on literature and to create an experimental design or study design. He/she can apply the methods and document, evaluate, present and critically assess the results obtained.

Teaching and Learning Methods:
After teaching and practicing the methods of scientific work relevant to them in a lecture with integrated exercise, the scientific conception of their own research project is worked out with each individual student in an individual exercise within the framework of a current agricultural science question. On the basis of literature work, the student proposes a research approach which is further developed into a concept (with study design or experimental design) together with the tutors. During the practical training he/she will widely independently carry out the conceptual design of the project under supervision. The contact time with the instructor varies depending on the research approach or methodology used (e.g. laboratory work, interviews, data analysis, etc.). He/she documents his/her results independently and carries out the evaluation and presentation of the results under supervision.

Media:

Reading List:
Script

Responsible for Module:
Hückelhoven, Ralph; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungsprojekt Agrarsystemwissenschaften - Biotechnologie der Nutztiere (Übung) (Übung, 2 SWS)
Bauer B, Flisikowski K

Forschungsprojekt Agrarsystemwissenschaften - Biotechnologie der Nutztiere (Praktikum) (Praktikum, 6 SWS)
Bauer B, Flisikowski K

Forschungsprojekt Agrarsystemwissenschaften - Agrarsystemtechnik (Praktikum) (Praktikum, 6 SWS)
Bernhardt H [L], Bernhardt H

Forschungsprojekt Agrarsystemwissenschaften - Agrarsystemtechnik (Übung) (Übung, 2 SWS)
Bernhardt H [L], Bernhardt H, Grebner S, Sebald C

Forschungsprojekt Agrarsystemwissenschaften - Pflanzenernährung (Übung) (Übung, 2 SWS)
Bienert G [L], Bienert G, Alcock T, Chen X, von Tucher S

Forschungsprojekt Agrarsystemwissenschaften - Pflanzenernährung (Praktikum) (Praktikum, 6 SWS)
Bienert G [L], Bienert G, Alcock T, Chen X, von Tucher S

Forschungsprojekt Agrarsystemwissenschaften - Ökonomik des Gartenbaus und Landschaftsbaus (WZ0031, deutsch) (Projekt, 10 SWS)
Bitsch V

Forschungsprojekt Agrarsystemwissenschaften - Tierernährung und Metabolismus (Übung) (Übung, 2 SWS)
Braun I, Kurek J, Liegsalz T, Steinhoff-Wagner J, Vorndran A

Forschungsprojekt Agrarsystemwissenschaften - Tierernährung und Metabolismus (Praktikum) (Praktikum, 6 SWS)
Braun I, Kurek J, Liegsalz T, Steinhoff-Wagner J, Vorndran A

Forschungsprojekt Agrarsystemwissenschaften - Aquatische Systembiologie (Praktikum) (Praktikum, 6 SWS)
Geist J [L], Beggel S, Geist J, Pander J

Forschungsprojekt Agrarsystemwissenschaften LS Governance in Intl. Agribusiness (WZ0031, deutsch) (Projekt, 5 SWS)
Glebe T

Forschungsprojekt Agrarsystemwissenschaften LS Governance in Intl. Agribusiness (WZ0031, deutsch) (Übung, 2 SWS)
Glebe T

Forschungsprojekt Agrarsystemwissenschaften LS Governance in Intl. Agribusiness (WZ0031, deutsch) (Übung, 2 SWS)
Glebe T

Forschungsprojekt Agrarsystemwissenschaften LS Governance in Intl. Agribusiness (WZ0031, deutsch) (Projekt, 5 SWS)
Glebe T

Forschungsprojekt Agrarsystemwissenschaften - Phytopathologie (Praktikum) (Praktikum, 6 SWS)
Hückelhoven R [L], Hein S, Hoheneder F, Hückelhoven R, Müller M, Steidele C

Forschungsprojekt Agrarsystemwissenschaften - Phytopathologie (Übung) (Übung, 2 SWS)
Hückelhoven R [L], Hückelhoven R

Forschungsprojekt Agrarsystemwissenschaften - Ökologischer Landbau / Pflanzenbausysteme (Praktikum) (Praktikum, 6 SWS)
Hülsbergen K [L], Gebhardt-Steinbacher C, Hülsbergen K, Mittermayer M

Forschungsprojekt Agrarsystemwissenschaften - Ökologischer Landbau / Pflanzenbausysteme (Übung) (Übung, 2 SWS)
Hülsbergen K [L], Hülsbergen K, Chmelikova L, Nätscher L, Gebhardt-Steinbacher C, Mittermayer M

Forschungsprojekt Agrarsystemwissenschaften - Bodenkunde (Übung) (Übung, 2 SWS)
Kögel-Knabner I [L], Kögel-Knabner I

Wissenschaftliches Arbeiten für Master Agrarsystemwissenschaften (Seminar, 1,5 SWS)
Lux-Endrich A

Vorstellung der Forschungsprojekte (M.Sc. Agrarsystemwissenschaften) (Seminar, ,5 SWS)
Lux-Endrich A, von Tucher S

Forschungsprojekt Agrarsystemwissenschaften - Agrarmechatronik (Praktikum) (Praktikum, 6 SWS)
Oksanen T

Forschungsprojekt Agrarsystemwissenschaften - Agrarmechatronik (Übung) (Übung, 2 SWS)
Oksanen T

Research Project Agricultural System Science - Livestock Systems (Lab Exercise) (Übung, 2 SWS)
Rufino M

Research Project Agricultural System Science - Livestock Systems (Practical lab course) (Praktikum, 6 SWS)
Rufino M, Hawkins J, Nevermann S, Sibilu H

Forschungsprojekt Agrarsystemwissenschaften - Lehrstuhl für Produktions- und Ressourcenökonomie (Praktikum) (WZ0031, deutsch) (Praktikum, 5 SWS)
Sauer J [L], Abate Kassa G, Frick F, Mennig P, Sauer J, Vrachioli M

Forschungsprojekt Agrarsystemwissenschaften - Lehrstuhl für Produktions- und Ressourcenökonomie (Übung) (WZ0031, deutsch) (Übung, 2 SWS)
Sauer J [L], Abate Kassa G, Frick F, Mennig P, Vrachioli M

Forschungprojekt Agrarsystemwissenschaften - Soil Biophysics and Environmental Systems (Praktikum) (Praktikum, 6 SWS)
Zare M [L], Moser D, Zare M

Forschungprojekt Agrarsystemwissenschaften - Soil Biophysics and Environmental Systems (Übung) (Übung, 2 SWS)
Zare M [L], Zare M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0027: Innovations in Agricultural Systems | Innovationen für Agrarsysteme

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer schriftlichen Prüfung (Klausur) von 120 Minuten Dauer - ohne Benutzung von Hilfsmitteln - erbracht. Die Klausur besteht aus einzelnen Prüfungsfragen, welche eigene entsprechende Textformulierungen erfordern.
Durch die Beantwortung dieser Fragen sollen die Studierenden nachweisen, dass sie zum einen die vielfältigen Herausforderungen unserer Zeit kennen und zum anderen zu den sich daraus für die Agrarsystemwissenschaften ergebenden Anforderungen seitens Gesellschaft und Wirtschaft Stellung nehmen können.
Ebenso wird überprüft, ob bzw. inwieweit sie im Hinblick auf die fünf Vertiefungsbereiche der Agrarsystemwissenschaften (Pflanzenproduktionssysteme, Tierproduktionssysteme, Agrarökosysteme, Agrarsystemökonomie, Agrarsystemtechnik) jeweilige neue Technologien und Forschungsergebnisse wiedergeben und nach ihrer Eignung für die Entwicklung zukünftiger Agrarsysteme einschätzen können.
Schließlich sollen die Studierenden ein neuartiges Agrarsystem der Zukunft, das grob skizziert im Rahmen einer Prüfungsfrage vorgegeben wird, nach ausgewählten Leistungs- und Nachhaltigkeitskriterien technologisch, ökologisch und ökonomisch analysieren und bewerten.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse der Agrarwissenschaften

Content:
Die Vorlesung gibt zunächst einen Überblick über wichtige globale Entwicklungstrends (z.B. wachsende Weltbevölkerung, Ressourcenverknappung, Klimawandel) sowie die sich für die Agrarsystemwissenschaften daraus ergebenden Herausforderungen. In diesem Zusammenhang

werden die notwendigen Rahmenbedingungen bzw. Vorgaben angesprochen, denen die Agrarsysteme der Zukunft verpflichtet sind.
Differenziert nach den einzelnen Vertiefungsbereichen Pflanzenproduktionssysteme, Tierproduktionssysteme, Agrarökosysteme, Agrarsystemökonomie und Agrarsystemtechnik werden in der Folge neue Technologien und ausgewählte Forschungsergebnisse vorgestellt, welche die Grundlage für zukünftige Agrarsysteme bilden können.
Ausgehend davon werden mögliche Agrarsysteme der Zukunft in Form von innovativen Szenarien und Konzepten skizziert. Dabei wird ein besonderes Augenmerk auf Nachhaltigkeits- und Effizienzkriterien gerichtet, welche aus ökonomischem, gesellschaftlichem und ökologischem Blickwinkel betrachtet werden.
Mögliche Potenziale, Grenzen, Chancen und Risiken der verschiedenen zukünftigen Agrarsysteme werden ebenfalls angesprochen.

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme am Modul sind die Studierenden in der Lage, den Blick auf die gesellschaftlichen und globalen Herausforderungen unserer Zeit zu fokussieren. Sie erkennen, vor welchen Herausforderungen die Agrarsystemwissenschaften in diesem Zusammenhang stehen. Insbesondere können die Studierenden im Hinblick auf die fünf Vertiefungsbereiche Pflanzenproduktionssysteme, Tierproduktionssysteme, Agrarökosysteme, Agrarsystemökonomie sowie Agrarsystemtechnik diskutieren, welche Agrarsysteme in der Zukunft geeignet erscheinen, einen Beitrag zur Lösung der globalen, aber auch regionalen Probleme zu leisten, und welche Methoden und innovativen Konzepte hierbei verfolgt werden. Zudem sind die Studierenden in der Lage, verschiedene Agrarsysteme der Zukunft hinsichtlich ausgewählter Nachhaltigkeits- und Effizienzkriterien zu bewerten.
Darüber hinaus sind die Studierenden befähigt, in den Lehrveranstaltungen vorgestellte Forschungsprojekte anzusprechen und deren Ergebnisse vor dem Hintergrund anstehender Herausforderungen einzuschätzen.

Teaching and Learning Methods:
Die genannten Themen werden den Studierenden in einer Ringvorlesung nahegebracht, die von Experten aus den jeweiligen Bereichen gehalten wird. Dabei werden die Studierenden zu ausgewählten Fragestellungen immer wieder zu Diskussionen angeregt, wodurch sie lernen sollen, unterschiedliche Sichtweisen und Perspektiven zu betrachten, Sachverhalte kritisch zu hinterfragen und dann sachlich und objektiv richtig einzuordnen.
Die Vorlesungen werden vornehmlich von Dozenten der TUM, teilweise aber auch von Gastdozenten gehalten.

Media:
Digitaler Semesterapparat mit PowerPoint-Präsentationen, ausgewählten Beiträgen etc.

Reading List:
Auf wissenschaftliche Publikationen und Beiträge wird seitens der Dozenten im Rahmen der jeweiligen Lehrveranstaltungen hingewiesen.

Responsible for Module:
Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Innovationen für Agrarsysteme (WZ0027, deutsch) (Vorlesung, 4 SWS)
Sauer J [L], Frick F, Steinhoff-Wagner J, Bernhardt H, Cabernard L, Görl J, Hafner B, Hückelhoven R, Hülsbergen K, Jaufmann E, Migende J, Müller M, Sebald C, Sixt T, Spiekers H, von Bloh M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1056: Nutrient Cycles in Agro-Ecosystems | Nährstoffkreisläufe in Agrarökosystemen

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in einer Klausur (120 min) schriftlich erbracht. Dabei soll ohne Hilfsmittel ein vertieftes Verständnis für die betrieblichen, regionalen und nationalen Kreisläufe von Nährstoffen und für Energieflüsse in Agrarökosystemen demonstriert werden. Aktuelle Probleme überlasteter Nährstoffkreisläufe, wie z.B. der Nährstoffverluste aus unterschiedlichen Systemen der Pflanzen- und Tierproduktion in angrenzende Ökosysteme und methodische Probleme der Bilanzierung von Stoffflüssen sollen erkannt werden. Wege zu einer Lösung, beispielsweise der Reduzierung von Nährstoffverlusten und Erhöhung der Nährstoffeffizienz, sollen gefunden und vor dem Hintergrund der Interaktion von agrarischer Landbewirtschaftung und Umwelt sowie bestehender Zielkonflikte bewertet werden. Die Bedeutung der Humusversorgung ackerbaulich genutzter Böden sowie die methodischen Herausforderungen bei der Modellierung der Humus- und Kohlenstoffdynamik in Böden sollen dargestellt werden. An Fallbeispielen soll gezeigt werden, mit welchen Indikatoren und Modellen die Nachhaltigkeit von Pflanzenbau- und Düngesystemen bewertet werden kann. Die Beantwortung der Fragen erfordert eigenständige Formulierungen.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Grundlagen der Pflanzenernährung und der Bodenkunde
Grundlagen des Pflanzenbaus und Kenntnisse der Produktion landwirtschaftlicher Kulturen
Grundlagen der Tierernährung und agrarökologische Kenntnisse

Content:
Das Modul beschäftigt sich mit der Problematik offener Kreisläufe von Nährstoffen und niedriger Nährstoffeffizienzen in agrarisch genutzten Ökosystemen sowie mit Managementsystemen für Umwelt und nachhaltige Landwirtschaft

1. Charakterisierung von Nährstoffkreisläufen im Agrarökosystem; Umweltbeeinträchtigungen durch Düngung und Nährstoffüberschüsse auf landwirtschaftlich genutzten Flächen, Nährstoffverluste insbesondere N und P aus Pflanzenbau- und Tierhaltungssystemen in die Hydrosphäre und Atmosphäre:
Ist-Situation, Einflussfaktoren und Maßnahmen zur Reduktion,
2. Bilanzierung von Stoffflüssen im Betrieb, auf regionaler und nationaler Ebene; Berechnung von Humusbilanzen und Analyse von Energieflüssen in Agrarsystemen.
3. Regelung der Interaktion von Landwirtschaft und Umwelt sowie auftretende Zielkonflikte, z.B. zwischen Pflanzenbau und Düngung, Ertragsbildung, Biodiversität und Bodenschutz
4. Nachhaltigkeit: Methoden und Indikatoren gestützte Modelle zur Analyse und Bewertung der Nachhaltigkeit im Pflanzenbau mit engem Bezug zur Nährstoffkreisläufen, Humusmanagement und Energieeffizienz.

Intended Learning Outcomes:
Nach Teilnahme an der Modulveranstaltung ist der Studierende in der Lage,
- Nährstoffverluste aus Agrarökosystemen zu charakterisieren und die Eignung von Maßnahmen zu deren Reduktion zu beurteilen,
- die ökologischen Folgen von Nährstoffüberschüssen zu bewerten,
- Nährstoffkreisläufe, Humus- und Energiebilanzen in Abhängigkeit von Betriebssystemen bzw. Standortbedingungen mit geeigneten Methoden zu analysieren,
- den Standort optimierten Einsatz von Nährstoffen und organischer Substanz zu berechnen und zu bewerten,
- gesetzliche Regelungen darzustellen und auf unterschiedliche Fragestellungen anzuwenden.

Teaching and Learning Methods:
Die Vorlesungen dienen zur Gliederung und systematischen Darstellung des Wissens.
Dabei werden Vorträge der Dozierenden ergänzt durch kurze Diskussionsphasen der Studierenden, um deren Vorwissen zu reaktivieren und erlerntes Wissen zu verarbeiten.

Media:
Präsentationen,
Fallbeschreibungen

Reading List:
Publikationen aus Fachzeitschriften (werden bereitgestellt)

Responsible for Module:
Hülsbergen, Kurt-Jürgen; Prof. Dr. agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Nährstoffkreisläufe in Agrarökosystemen (Vorlesung, 4 SWS)
Hülsbergen K [L], Schmidhalter U, Hu Y, Hülsbergen K, von Tucher S, Mittermayer M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0030: Project Agricultural Systems | Projekt Agrarsysteme

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:**	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Projektarbeit und einer mündlichen Prüfung (30 Min.) erbracht.
Die Projektarbeit besteht aus einem schriftlichen Bericht und einer Präsentation. Im Bericht (ca. 20 Seiten) weisen die Studierenden nach, dass sie in der Lage sind, Agrarsysteme zu analysieren, zu bewerten und zu optimieren. Ein Analyseschwerpunkt liegt auf Innovationen in Agrarsystemen (Digitalisierung, Sensorik, Robotik, Precision Farming, und andere Zukunftstechnologien) und deren ökologische, ökonomische und soziale Wirkungen. Dabei umfasst der Bericht den methodische Ansatz sowie die Beschreibung und Diskussion der wichtigsten Ergebnisse des Projektes. In der Präsentation (20 Min.) mit anschließener Diskussion (ca. 20 Min.) weisen die Studierenden nach, dass sie ihr Projekt strukturiert, präzise und anschaulich darstellen und diskutieren können sowie dabei mit rhetorischer Sicherheit professionell auftreten können.
Am Ende der Modulveranstaltung wird in einer mündlichen Prüfung überprüft, ob die Studierenden ihre Projektergebnisse hinsichtlich der Bewertung von Umwelt- und Klimawirkungen sowie der ökonomischen und sozialen Nachhaltigkeit auch in größere Zusammenhänge einordnen und bewerten können. Bericht, Präsentation und mündliche Prüfung gehen jeweils mit einem Drittel in die Modulnote ein.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Kenntnisse in den Fachgebieten Pflanzenproduktionssysteme, Tierproduktionssysteme, Agrarökosysteme, Agrarökonomie und Agrarsystemtechnik. Mindestens 30 CP, davon mindestens 15 CP aus Pflichtmodulen müssen erbracht sein, um die Voraussetzungen für eine Teilnahme am Modul Agrarische Landnutzungssysteme nachzuweisen.

Content:
Gegenstand des Moduls sind gegenwärtige und zukünftige Agrarsysteme, Innovationen in Agrarsystemen und deren potenzielle Wirkungen. Im Mittelpunkt der Projektarbeit steht das gesamte Agrarsystem in der Vernetzung der Subsysteme.
Fachliche Inhalte:
Strukturen, Stoff- und Energieflüsse, Interaktionen in Agrarsystemen, Beziehungen von Landwirtschaft und Umwelt. Einflussfaktoren auf Agrarsysteme (z.B. Standortbedingungen, gesellschaftliche Rahmenbedingungen, Innovationen, …). Agrartechnische Innovationen (Digitalisierung, Sensorik, Automatisierung, ...) und ihr Einfluss auf künftige Agrarsysteme.
Methodische Inhalte:
Analysemethoden (z.B. Indikatoren und Bilanzierungsansätze zur Bewertung von Umweltwirkungen und Nachhaltigkeit von Agrarsystemen), ökonomische Methoden zur Beurteilung der Wirtschaftlichkeit, ökonomischen und sozialen Nachhaltigkeit von Agrarsystemen.

Intended Learning Outcomes:
Die Studierenden sind nach der erfolgreichen Teilnahme an diesem Modul in der Lage, in Agarsystemen und Agrarlandschaften ablaufende Prozesse und Interaktionen (z.B. Nährstoffkreisläufe, Energieflüsse, Biodiversität und Regulation, Landschaftswasserhaushalt, Erosion, ...) in ihrer Komplexität darzustellen. Sie entwickeln ein Verständnis für das Gesamtsystem, die Interaktionen (z.B. Stoff- und Energieflüsse) zwischen Boden - Pflanze - Tier - Umwelt. Sie besitzen die Fähigkeit, ausgewählte naturwissenschaftliche und/oder ökonomische Methoden und Indikatoren anzuwenden, um die Agrarsysteme hinsichtlich der Umwelt- und Klimawirkungen, der ökonomischen und sozialen Nachhaltigkeit zu analysieren und zu bewerten. Sie sind befähigt, interdisziplinär und projektorient Fragestellungen zur Weiterentwicklung und Optimierung von agrarischen Landnutzungssystemen (z.B. Ackerbau- und Grünlandsysteme, Tierhaltungssysteme, Systeme zur Erzeugung und Nutzung Nachwachsender Rohstoffe, Agroforstsysteme) zu bearbeiten. Darüberhinaus sind sie in der Lage, die Ergebnisse ihrer projektorientierten Untersuchungen und entwickelten Konzepte in Präsentationen und Fachdiskussionen darzustellen.

Teaching and Learning Methods:
Durchführung eines Projektes zu einer agrarwissenschaftlichen Problemstellung der Analyse, Bewertung und/oder Optimierung eines agrarischen Landnutzungssystems.
Als Untersuchungsobjekte eignen sich je nach Fragestellung z.B. Agrarsysteme, die in agrarwissenschaftlichen Forschungsstationen (Versuchsbetrieben) experimentell erforscht werden, aber auch Praxisbetriebe, die neue Technologien einsetzen. Die Projektdurchführung erfolgt in Gruppen von drei (bis max. fünf) Studierenden, die interdisziplinär eine agrarwissenschaftliche Fragestellung bearbeiten, die von mindestens zwei Dozenten betreut werden. Die Projektaufgaben sind so formuliert, dass naturwissenschaftliche und/oder ökonomische Methoden zur Anwendung kommen. Die Studierenden bearbeiten weitgehend eigenständig dieses Projekt, erhalten dabei aber Unterstützung und Anleitung durch die betreuenden Dozierenden. Die Zwischenergebnisse der Projektarbeit werden mit den betreuenden Dozierenden abgestimmt. Die Endergebnisse des Projektes werden in einer Präsentation vorgestellt (vor allen am Modul beteiligten Studierenden und Dozenten).

Media:
Präsentationsformen zur Vorstellung der Projektergebnisse: PowerPoint, Flipchart

Reading List:
wissenschaftliche Publikationen

Responsible for Module:
Hülsbergen, Kurt-Jürgen; Prof. Dr. agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Projekt Agrarsysteme (Projekt, 10 SWS)
Hülsbergen K [L], Gebhardt-Steinbacher C, Hülsbergen K, Mittermayer M, Steinhoff-Wagner J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1513: Production and Resource Economics | Produktions- und Ressourcenökonomie

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird schriftlich im Rahmen einer Klausur (120 Minuten) erbracht. Ein Teil der Klausur umfasst Multiple-Choice-Fragen zum Verständnis grundsätzlicher produktions- und ressourcenökonomischer Konzepte sowie von Modellen des ökonomischen Umweltmanagements. In einem weiteren Teil der Klausur mit offenen Fragen sollen die Studierenden in eigenen Worten nachweisen, dass sie in der Lage sind, anhand theoretischer Konzepte und Modelle empirische Probleme in der nachhaltigen und effizienten Produktion im Rahmen verschiedener Agrarsysteme strukturell zu analysieren. Schließlich sollen sie z.B. anhand eines Softwareoutputs zeigen, dass sie statistische und ökonometrische Analyseergebnisse im Bereich ökonomischer Produktion und nachhaltigen Managements interpretieren sowie bewerten können.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Bachelor Landnutzung bzw. Bachelor Agrarwissenschaften und Gartenbauwissenschaften, andere Bachelorabschlüsse

Content:
Wesentlicher Gegenstand des Moduls ist die Behandlung mikroökonomischer Fragestellungen in landwirtschaftlichen Unternehmen und verschiedenen Agrarsystemen auf der Grundlage von Betriebsmodellkalkulationen (z.B. Anpassung an veränderte agrar- und umweltpolitische Rahmenbedingungen, Unternehmenswachstum, Ressourcenveränderungen, Klimawandel, politische Rahmenbedingungen und gesellschaftliche Anforderungen etc.). Ebenso werden die Implikationen und Anforderungen an natürliche Ressourcen durch die Produktion aufgezeigt und in ihrem agrarsystemischen Zusammenhängen analysiert und optimiert.
Weitere Inhalte sind:

- Ökonomische, umweltbezogene und soziale Aspekte der nachhaltigen Produktion im agrarsystemischen Kontext;
- Ressourcen- und Umweltmanagement;
- ökonomische Nachhaltigkeitsbetrachtungen:
- öffentliche und private Standards;
- Politikeinflüsse und –anforderungen;
- Arbeitskräfte und gesellschaftliche Erwartungen;
- statistische Modellierung von Produktionstechnologien und Ressourcennutzung.

Intended Learning Outcomes:
Die Studierenden lernen zentrale mikroökonomische Konzepte und Modelle zur Lösung produktionstechnischer und nachhaltiger Betriebsentscheidungen anzuwenden. Hierbei werden vielfältige Bezüge zu systemisch-agrarwissenschaftlichen Zusammenhängen (v.a. Pflanzen-, Tier, Technologiebezogen) hergestellt und in ihrer Effizienz wie Nachhaltigkeitsrelevanz analysiert. Hierzu werden reale Datensätze mittels statistischer Methoden computerbasiert modelliert und analysiert. Nach dem Besuch des Moduls sind die Studierenden in der Lage,
- produktionstechnische und betriebswirtschaftliche Zusammenhänge in landwirtschaftlichen Unternehmen im Rahmen verschiedener Agrarsysteme zu analysieren,
- eine ökonomische Bewertung der Effizienz und Nachhaltigkeit auf Einzelbetriebsebene anzuwenden,
- die Rolle der landwirtschaftlichen Produktion und Nutzung natürlicherRessourcen in einer nachhaltigen Wertschöpfungskette einzuschätzen sowie
- Methoden des Betriebs- und Ressourcenmanagements (wie z.B. computerbasierte Modellierung von Ressourcennutzung, stochastische und lineare Produktionsplanung) anzuwenden.

Teaching and Learning Methods:
Im Rahmen des Lehrformates Vorlesung kommen überwiegend Vorträge sowie Diskussion von konkreten Fallstudien zum Einsatz. Diese werden durch computerbasierte Datenanalysen und Fallmodellierungen komplementiert.
Die Vermittlung und Anwendung der gelehrten Methoden (Produktionsmodellierung und -optimierung, Ressourcenmodellierung, Simulation von Massnahmen) erfolgt anhand realer Datensätze sowie computerbasierter Modellierung und Analyse auf der Basis von Fallbeispielen.

Media:
Präsentationen und Skripte; wissenschaftliche Artikel; Datensätze; statistische Software

Reading List:
Coelli, T.J. (2005). An Introduction to Efficiency and Productivity Analysis. Springer.
Rasmussen, S. (2012). Production Economics. Springer
Tietenberg, T. (2019). Natural Resource Economics. Kluwer.
Field, B. (2016). Ntural Resource Economics. Waveland Press.
National Resource Council 2010, Toward Sustainable Agricultural Systems in the 21st Century, Washington/D.C.: National Academies Press;
sowie weitere Artikel und Webseiten nach Absprache

Responsible for Module:
Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Produktions- und Ressourcenökonomie (WZ1513, deutsch) (Vorlesung, 4 SWS)
Sauer J [L], Frick F, Ober C, Vrachioli M
For further information in this module, please click campus.tum.de or here.

Elective Modules | Wahlmodule

Plant Production Systems | Pflanzenproduktionssysteme

Module Description

WZ1063: Epidemiology and Management of Plant Diseases in Agriculture | Epidemiologie und Management von Pflanzenkrankheiten im Ackerbau

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung besteht aus einer 90 minütigen Klausur. In dieser soll ohne Hilfsmittel nachgewiesen werden, dass die epidemiologischen Grundlagen der Krankheiten in Ackerbaukulturen und ihre experimentelle Anwendung differenziert charakterisiert werden können. Dazu müssen die methodischen Kenntnisse der durchgeführten Experimente an dem ausgewählten Pathosystem auf weitere Wirt-Pathogen-Interaktionen transferiert werden.
Dabei wird die im Seminar erworbene Kompetenz die Methoden zur Durchführung von Infektions-Experimenten an Versuchspflanzen anzupassen überprüft. Die Studierende sollen zeigen, dass Sie auf der Basis von epidemiologischen Zusammenhängen Pflanzenschutzkonzepte entwickeln und Managementsysteme (Decision support systems) im integrierten Pflanzenschutz bewerten können. Die Beantwortung der Fragen erfordert eigene Formulierungen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen der Phytopathologie und des Pflanzenschutzes, Absolvierung des Moduls Phytopathologie und Pflanzenzüchtung (B.Sc.) oder vergleichbarer Veranstaltungen.

Content:
Das Modul Epidemiologie und Management von Pflanzenkrankheiten im Ackerbau beinhaltet folgende Themenschwerpunkte:

1. Epidemiologie und Schadrelevanz verschiedener Schaderreger
2. Anwendung von integrierten Pflanzenschutzkonzepten
3. Optimierung verschiedener Pflanzenschutzmaßnahmen zum Erreichen eines größtmöglichen wirtschaftlichen Erfolges bei nachhaltiger Bewirtschaftungsart
4. Modellexperimente zur Epidemiologie der Pflanzenkrankheiten (gezielte Inokulation mit Schaderregern unter kontrollierten Bedingungen, Durchführung von Sensitivitäts-Tests)
5. Management der wichtigsten Blattkrankheiten im Getreide
6. Management der wichtigsten Krankheiten im Mais
7. Management der wichtigsten Krankheiten im Raps
8. Management der wichtigsten Krankheiten der Kartoffel.
9. Management der wichtigsten Krankheiten der Zuckerrübe.
10. Aktuelle Forschungsergebnisse und Neuentwicklungen im Bereich des Pflanzenschutzes, die in innovative Pflanzenschutzkonzepte zu integrieren sind.
11. Gesellschaftliche Zielkonflikte im Bereich chemischer Pflanzenschutz und Balancierung von ökologischen und ökonomischen Aspekten.

Intended Learning Outcomes:
Nach der Teilnahme am Modul erinnern die Studierenden grundlegende Kenntnisse epidemiologischer Zusammenhänge, können Schaderreger in wichtigen Ackerkulturen benennen, kennen integrierte Bekämpfungsmöglichkeiten von Schaderregern und können diese bewerten und optimieren. Die Studierenden sind in der Lage, anhand von Populations- und Schadentwicklungen Prognosen zum Epidemieverlauf zu machen und unter Berücksichtigung ökologischer und wirtschaftlicher Aspekte Maßnahmen zur nachhaltigen Krankheitsbekämpfung vorzuschlagen. Dies gilt in erster Linie für den konventionellen Pflanzenbau erfasst aber auch Maßnahmen des ökologischen Anbaus. Studierende können unter Anleitung gezielte Experimente im Gewächshaus und unter kontrollierten Bedingungen (z.B. Klimakammer) zur Epidemiologie von Pflanzenkrankheiten durchführen. Des Weiteren sind die Studierenden in der Lage, sich selbständig neues theoretisches Wissen oder neue Technologie im Bereich des integrierten Pflanzenschutzes aus Originalliteratur (wie
z.B. Forschungsberichte und Publikationen) anzueignen und hinsichtlich ihres Einsatzes für innovative Pflanzenschutzkonzepte beurteilen zu können.

Teaching and Learning Methods:
Die Vorlesung legt die theoretischen Grundlagen der Krankheitsverläufe und der Bekämpfungsmaßnahmen in verschiedenen Ackerkulturen. In Rahmen von Übungen erfassen die Studierenden die Krankheitsverläufe selbstständig. Durch spezifische Steuerung und im Modellsystemen werden wichtige epidemiologische Parameter variiert. Das Seminar schafft Vertiefungen in Bereichen, die an den Vorlesungsinhalt angrenzen und trainiert die Fähigkeit, auf Erlerntem aufbauend neue Inhalte zu erschließen und darzustellen. Die Themenauswahl des Seminars befördert gezielt auf eine anschließende vergleichende Diskussion u.a. der ökologischen und ökonomischen Konsequenzen von chemischen und ökologischen Pflanzenschutzmaßnahmen.

Media:
Powerpoint oder Posterpräsentation

Reading List:
Hoffmann und Schmutterer, 1999: Parasitäre Krankheiten und Schädlinge an landwirtschftlichen Nutzpflanze; Poehling und Verreet, 2013: Lehrbuch der Phytomedizin

Responsible for Module:
Prof. Dr. rer. nat. Ralph Hückelhoven hueckelhoven@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Epidemiologie und Management von Pflanzenkrankheiten im Ackerbau (Übung, 1 SWS)
Hausladen J

Epidemiologie und Management von Pflanzenkrankheiten im Ackerbau (Vorlesung, 2 SWS)
Hausladen J, Hückelhoven R

Epidemiologie und Management von Pflanzenkrankheiten im Ackerbau (Seminar, 1 SWS)
Hausladen J, Hückelhoven R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0068: Innovations in Plant Production Systems | Innovationen im Pflanzenbau

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer schriftlichen Klausur (120 min) erbracht.
Es wird geprüft, ob die Studierenden grundlegende Kenntnisse zu den Herausforderungen im Pflanzenbau, den Lösungsansätzen und Innovationen erworben haben. Die Studierenden sollen nachweisen, dass sie die unterschiedlichen Ansätze, Strukturen und Innovationen im ökologischen und konventionellen Pflanzenbau verstehen und in Fallbeispielen anwenden können.
Die Studierenden sollen in der Lage sein, für eine spezielle pflanzenbauwissenschaftliche Fragestellung einen geeigneten Forschungsansatz abzuleiten und ein Versuchsdesign zu skizzieren. Sie können beispielsweise einschätzen, bei welchen Forschungsfragen Versuche unter Praxisbedingungen (On-Farm-Research), Exakt-Feldversuche oder Dauerfeldexperimente besser geeignet sind.
Die Studierenden können die Anwendungspotenziale von digitalen Entscheidungsunterstützungssystemen im Pflanzenbau charakterisieren, incl. der noch bestehenden Restriktionen, und können diese in Anwendungsbeispielen hinsichtlich ihres Innovationspotenzials richtig bewerten.
Die Studierenden sind in der Lage, verschiedene Systeme der Nachhaltigkeitsbewertung und Ökobilanzierung im Pflanzenbau hinsichtlich der unterschiedlichen methodischen Ansätze, der Vor- und Nachteile der Anwendung sowie der Aussagegrenzen einzuschätzen.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Pflanzenbau und Pflanzenernährung, Agrarökosysteme, Ökologischer Landbau (Bachelorstudiengang Agrarwissenschaften und Gartenbauwissenschaften oder vergleichbare Studiengänge)

Nährstoffkreisläufe in Agrarökosystemen, Geoinformationssysteme und Modellierung, Innovationen für Agrarsysteme (Master Agrarsystemwissenschaften)

Content:

Am Beispiel aktueller Forschungsprojekte wird dargestellt, welche Forschungsfragen im Pflanzenbau bearbeitet werden, welche Forschungsmethoden dabei zur Anwendung kommen und welche Ergebnisse erzielt werden.
Auf folgende Pflanzenbausysteme und Innovationen wird im Detail eingegangen:
- Systemvergleich ökologischer und konventioneller Pflanzenbausysteme: Analyse, Bewertung und Optimierung der Ertragsleistungen, der Wirkungen auf Böden und Umwelt, nachhaltige Intensivierung und Ertragssteigerung im ökologischen Pflanzenbau, Ansätze zur Fusion ökologischer und konventioneller Systeme
- Messung und Modellierung von Treibhausgasemissionen in ökologischen und konventionellen Systemen, Maßnahmen zur wirksamen Treibhausgasminderung
- Kohlenstoffbindung in Böden in Abhängigkeit von Fruchtfolge, Bodenbearbeitung und Düngung. Möglichkeiten und Grenzen der C-Sequestrierung, pflanzenbauliche und agrarökologische Wirkungen sowie Einsatzpotenzial von Pflanzenkohle
- Agrarökologische Leistungen von Agroforstsystemen, Förderung von Biodiversität durch nachwachsende Rohstoffe und Energiepflanzenfruchtfolgen
- Anwendung satelliten- und sensorgestützter Verfahren zur Analyse der räumlichen Variabilität von Boden- Pflanzen-, und N-Bilanz-Parametern auf heterogenen Schlägen
- Entwicklung, Praxiserprobung und Validierung digitaler Nährstoffmanagementsysteme und Entscheidungsunterstützungssysteme im Pflanzenbau
- Nachhaltigkeitsbewertung und Ökobilanzierung im Pflanzenbau.

Intended Learning Outcomes:

Nach der erfolgreichen Teilnahme sind die Studierenden in der Lage,
- grundlegende Herausforderungen (z.B. Klimaänderungen, Biodiversitätsverlust, Boden- und Ressourcenschutz, internationaler Wettbewerb, steigende gesellschaftliche Erwartungen, Einschränkungen beim Einsatz chemisch-synthetischer Pflanzenschutzmittel) an die Gestaltung zukunftsfähiger und nachhaltiger Pflanzenbausysteme detailliert darzustellen und zu begründen
- verschiedene Lösungsansätze (z.B. klimaresilienter und biodiversitätsfördernder Pflanzenbau, Anwendung digitaler Entscheidungsunterstützungssysteme und Precision Farming Technologien, ökologischer Landbau, Agroforstsysteme) zu beschreiben und einzuordnen
- das jeweilige Anwendungs- und Innovationspotenzial zu bewerten sowie mögliche Effekte auf Ertrag und Ertragsstabilität, Produktqualität, Umwelt- und Klima zu charakterisieren
- methodische Ansätze der feldexperimentellen Erforschung und Weiterentwicklung von Pflanzenbausystemen, z.B. Dauerfeldexperimente, darzustellen sowie die Eignung für definierte Forschungsfragen zu bewerten
- Forschungsansätze des On-Farm-Research zu beschreiben und an Anwendungsbeispielen zu demonstrieren

- Möglichkeiten und Methoden zur Nutzung digitaler Daten (Sensordaten, Satellitendaten) im Pflanzenbau an Beispielen aufzuzeigen
- Anforderungen an digitale Management- und Entscheidungsunterstützungssysteme im Pflanzenbau, z.B. digitale Tools zur Fruchtfolgeoptimierung, webbasierte Systeme des Nährstoffmanagements, zu formulieren und an Beispielen den prinzipiellen Aufbau und die Anwendung dieser Systeme zu erklären

Teaching and Learning Methods:
Einführend wird von den beteiligten Dozent*innen ein Überblick gegeben zu den grundlegenden Herausforderungen an den Pflanzenbau (global und regional) sowie unterschiedlichen Strategien und Lösungsansätzen, um diesen Herausforderungen zu begegnen.
Dann erfolgt eine detaillierte Vorstellung von jeweils einem Innovationsschwerpunkt im Pflanzenbau in Vorlesungen.
In diese Vorlesungen sind Nachwuchswissenschaftler/innen einbezogen, die ihre neuesten Forschungsarbeiten zur Weiterentwicklung von Pflanzenbausystemen präsentieren und mit den teilnehmenden Studierenden diskutieren.
Die Vorlesungen sind so aufgebaut, dass genügend Zeit zur Verfügung steht für Diskussionen, die Beantwortung von Fragen der Studierenden, die Einordnung der Forschungsergebnisse.
Alle Vorlesungsfolien werden den Studierenden zur Vor- und Nachbereitung Verfügung gestellt.
Zu speziellen Themengebieten werden aktuelle wissenschaftliche Publikationen, statistische Daten, gesetzliche Regelungen und Konzepte zur Weiterentwicklung des Pflanzenbaus Verfügung gestellt. Die Grundaussagen dieser Dokumente werden erläutert und in den Gesamtkontext des Moduls gestellt.
Exkursionen zur Besichtigung pflanzenbaulicher Versuche in agrarwissenschaftlichen Forschungsstationen und Praxisbetrieben ergänzen die Vorlesungen.

Media:
Vorlesungspräsentationen, wissenschaftliche Publikationen und sonstige Materialien wie aktuelle Markt- und Anbaustatistiken, Gesetze und Verordnungen, Anbaurichtlinien, Konzeptpapiere (werden von den Dozent*innen bereitgestellt).

Reading List:

Responsible for Module:
Hülsbergen, Kurt-Jürgen; Prof. Dr. agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1039: Model Experiments in Plant Nutrition | Modellexperimente zur Pflanzenernährung

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Präsentation (30 min insg.) erbracht. Diese setzt sich aus einer 20-minütigen Präsentation mit anschließender Diskussion (10 min.) zusammen, ergänzt durch eine kurze schriftliche Aufarbeitung (ca. 3000 Wörter). Es soll nachgewiesen werden, dass der Studierende in der Lage ist, die im Verlauf der Lehrveranstaltungen erzielten Resultate einer experimentellen wissenschaftlichen Aufgabenstellung (z.B. des Einflusses von abiotischem Stress auf verschiedene Parameter des Pflanzenwachstums) in Form eines Vortrags mit anschließender Diskussion in begrenzter Zeit anschaulich, übersichtlich und verständlich darzustellen. Hierbei sind auf Basis des wissenschaftlichen Hintergrunds die Fragestellung abzuleiten, die verwendeten Methoden zu begründen und ihre Eignung zu beurteilen, sowie die Ergebnisse strukturiert darzustellen und zu bewerten und im Kontext aller ermittelten Parameter zu diskutieren.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundkenntnisse im Fach Pflanzenernährung

Content:
Es wird ein wissenschaftlicher Versuch geplant, durchgeführt und ausgewertet zu einem aktuellen Forschungsthema im Bereich der Agrarsystemwissenschaften, wie zum Beispiel: Pflanzenernährung, Wachstum und Pflanzenentwicklung unter abiotischen Stressbedingungen (Trockenheit, Nährstoffmangel, -überschuss), Anpassungsmöglichkeiten der Pflanze an Klimaveränderungen, Strategien zur Mitigation von Klimaveränderungen.
Dabei werden neben theoretischen Kenntnissen zur Thematik und zur Versuchsdurchführung auch agrikulturchemische (z.B. Mineralstoffanalysen), ökophysiologische (z.B. Pflanzenwasserstatus,

osmotische Anpassung, Blatttemperatur) und molekularbiologische Analyse- und Messmethoden sowie Imaging-based Phänotypisierungsmethoden eingesetzt und erprobt.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage:
- den im Schwerpunkt vermittelten theoretischen Hintergrund (z.B. zu Ursachen und Folgen von abiotischem Stress) zu erfassen,
- die Planung und Durchführung von Experimenten zur Pflanzenernährung im System Pflanze-Boden-Umwelt unter Anleitung auszuführen und die Ergebnisse im Hinblick auf die Fragestellung zu analysieren,
- eine geeignete Methodik aus dem Bereich Pflanzenernährung, insbesondere agrikulturchemische und ökophysiologische Messmethoden sowie molekularphysiologische Ansätze für die Fragestellung auszuwählen und deren Eignung für die Beantwortung der Frage zu bewerten,
- die Auswertung und Dokumentation der Ergebnisse in geeigneter Weise durchzuführen,
- die wissenschaftliche Aufbereitung der erzielten Ergebnisse durchzuführen.

Teaching and Learning Methods:
Der Vorlesungsteil findet übungsbegleitend statt und dient der Vermittlung des spezifischen Grundwissens (z. B. zu Ursachen und Bedeutung von abiotischem Stress bzw. den methodischen Grundlagen). Die Übung (bestehend aus technischen, labortechnischen und chemischen Laborarbeiten) dient dem Erwerb von Erfahrungen hinsichtlich der Eignung der Methodik für die Fragestellung sowie für die Bereitstellung von Daten. Die durch die Studierenden durchgeführte Recherche von relevantem Material und das Studium der Literatur ergänzt bereitgestelltes Material und dient der Bearbeitung einer spezifisch vertiefen Aufgabenstellung (z.B. Wirkung von abiotischem Stress auf Pflanzenwachstum).

Media:
Präsentation, Übungsblätter, Experiment, Tafelarbeit, Film, Online-Angebot

Reading List:
Marschner, P. (ed), 2012: Marschner's Mineral Nutrition of Higher Plants, Academic Press London, 3rd Edition. Originalarbeiten je nach Them

Responsible for Module:
Bienert, Gerd Patrick; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1077: Renewable Resources | Nachwachsende Rohstoffe

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In der schriftlichen Prüfung (Klausur, 120 min.) wird bewertet, ob die Studierenden in der Lage sind, die Anbaupotenziale, die Nutzungsoptionen und die ökologischen Wirkungen Nachwachsender Rohstoffe (z.B. unterschiedlicher Bioenergielinien) zu beurteilen. In der Prüfung zeigen die Studierenden, ob sie die Analysenmethoden (z.B. Life cycle assessment, Energie- und Treibhausgasbilanzierung Nachwachsender Rohstoffe, Erosionsmodellierung) verstanden haben und Untersuchungsergebnisse bei Anwendung dieser Methoden richtig interpretieren und bewerten können. Es wird beurteilt, in wieweit die Studierenden in der Lage sind, Anbausysteme und Logistiksysteme Nachwachsender Rohstoffe zu analysieren und zu optimieren. Dabei beantworten die Studierenden ohne Hilfsmittel mit eigenen Formulierungen die Prüfungsfragen. Sie geben Definitionen wieder, erläutern Zusammenhänge, Funktionsprinzipien und Logistikkonzepte, skizzieren ausgewählte NAWARO-Anlagen/Bauteile.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Kenntnisse der Agrarwissenschaften (Pflanzenwissenschaften, Pflanzenernährung, Agrarsystemtechnik, Agrarökologie)

Content:
Gegenstand des Moduls sind NAWARO-Anbau- und Verwertungssysteme zur energetischen und stofflichen Nutzung sowie deren agrarökologische Wirkungen.
Fachliche Inhalte: Pflanzenbausysteme zur Erzeugung nachwachsender Rohstoffe (NAWARO) für die stoffliche und energetische Verwertung.
Umwelteffekte des Anbaus der NAWARO-Pflanzen, insbesondere Wirkungen auf Böden - Bodenschadverdichtung, Bodenrosion, Humusdynamik und C-Sequestrierung, Effekte auf die

Biodiversität. Grundlagen der Biogaserzeugung. Biogaserzeugung im ökologischen Landbau - Einbindung von Biogasanlagen in landwirtschaftliche Betriebssysteme.
Methodische Aspekte: Vermittlung von Methoden zur ökologischen Analyse von NAWARO-Prozessketten (Life cycle assessment, Stoff- und Energiebilanzierung). Analyse des Prozesses der Biogaserzeugung, Energiepotenziale, Energiebilanzen des Anbaus und der Prozesskette.

Intended Learning Outcomes:
Die Studierenden sind nach der erfolgreichen Teilnahme an diesem Modul in der Lage, wichtige Nutzungssysteme Nachwachsender Rohstoffe (z.B. Biogaserzeugung, Biokraftstofferzeugung, Agroforstsysteme mit Gehölzen zur energetischen Nutzung) darzustellen und hinsichtlich ihrer komplexen Wechselbeziehungen (z.B. Konkurrenz, Zielkonflikte, Synergieeffekte) zu Systemen der Nahrungserzeugung sowie zu naturnahen Ökosystemen zu bewerten. Sie können die methodischen Grundlagen zur Analyse von Umwelt- und Klimawirkungen Nachwachsender Rohstoffe und ihrer Logistiksysteme anwenden.
Dabei sind Sie in der Lage, Anbau- und Nutzungssysteme Nachwachsender Rohstoffe hinsichtlich ihrer Wirkung auf die Bodenfruchtbarkeit, die Bodenschadverdichtung, die Bodenerosion und die Biodiversität zu analysieren und zu bewerten. Des Weiteren können sie Ergebnisse der Energie- und Treibhausgasbilanzierung von NAWARO-Prozessketten interpretieren.Die Studierenden können die Nutzungsoptionen und Entwicklungsperspektiven Nachwachsender Rohstoffe einschätzen.

Teaching and Learning Methods:
In Vorlesungen mit interdisziplinärer Ausrichtung werden von den Dozierenden die Grundlagen Nachwachsender Rohstoffe vermittelt, verschiedene Optionen der energetischen und stofflichen Nutzung von NAWARO im Überblick aufgezeigt, Pflanzenproduktions- und Logistikkonzepte zur Erzeugung von NAWARO dargestellt sowie die Methoden zur Analyse und Bewertung von Umwelt- und Klimawirkungen beispielhaft demonstriert. Bei der Wissensvermittlung in den Vorlesungen werden neben den theoretischen, konzeptionellen sowie naturwissenschaftlichen Grundlagen auch zahlreiche Praxisbeispiele zur Erzeugung und Nutzung von NAWARO umfassend erläutert und diskutiert. Ergänzend zur Vorlesung finden Exkursionen statt, in denen Anbausysteme (z.B. Feldversuche mit Energiepflanzen, Agroforstsysteme) und Nutzungssysteme von NAWARO (z.B. Biogasanlagen) vorgestellt werden, um das theoretische Wissen an Praxisbeispielen zu vertiefen.

Media:
Vorlesungspräsentationen, wissenschaftliche Artikel

Reading List:
ausgewählte wissenschaftliche Artikel

Responsible for Module:
Kurt-Jürgen Prof. Hülsbergen kurt.juergen.huelsbergen@mytum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Nachwachsende Rohstoffe (Vorlesung, 4 SWS)

Hülsbergen K [L], Hülsbergen K, Bernhardt H, Chmelikova L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0046: Plant Breeding, Experimental Design and Analysis | Pflanzenzüchtung und Versuchswesen

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The final examination is a written test (90 min.) without additional material. Students demonstrate in the exam that they can describe and interprete the entire breeding process: prebreeding, breeding methodology, variety testing and protection. Using practical examples students show that they understand different breeding strategies and are able to evaluate the required technologies. Questions require a student response expressed in their own words.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in plant breeding and applied statistics, botany and genetics

Content:
Plant diversity is an integral part of resilient agroecosystems. The task of plant breeding is the provision of better yielding varieties. The breeding process is influenced by many elements of an entire agroecosystem that are interconnected. Plant breeding has to consider all elements of a complex ecosystem.
Participants will acquire a profound understanding of important parameters in plant breeding like heritability, phenotypic and genotypic correlations. Breeding strategies and optimal allocation of resources will be presented. Experimental designs relevant for plant breeding, their respective dimensions and analysis will be introduced. Optimal breeding schemes will be exemplified with examples from crop breeding (maize, wheat, barley, potato). The specific characteristics of different breeding categories (line-, population-, clone- and hybrid breeding) will be developed. The importance of native biodiversity for plant breeding (prebreeding) will be discussed. Practical examples of genome-based breeding and other breeding technologies will be given. Principles of varity testing, protection and distribution will be introduced.

Intended Learning Outcomes:
After sucessfull participation of the module students are able to understand and design optimal breeding programs based on their knowledge of prebreeding, breeding methodology, selection theory and state of the art breeding technologies. Students can differentiate between breeding categories and assess the efficiency of breeding strategies. Furthermore they are able to evaluate the potential of new breeding technologies and to analyse them in a biological and socio-economic context. They can evaluate the consequences of different breeding schemes on cultivar registration.

Teaching and Learning Methods:
The lecture with power point presentations provides the theoretical background and concepts. The lecture is accompanied with practical demonstrations and excursions (e.g. to private breeding companies).

Media:
Powerpoint presentations, panel work, exercises, practical demonstrations

Reading List:
Rex Bernardo: Breeding for Quantitative Traits in Plants
Michael Lynch and Bruce Walsh: Genetics and Analysis of Quantitative Traits
Heiko Becker (2011) Pflanzenzüchtung

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Pflanzenzüchtung und Versuchswesen (Vorlesung, 4 SWS)
Mohler V, Ouzunova M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0047: Plant Stress Physiology | Plant Stress Physiology

Version of module description: Gültig ab summerterm 2025

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination contains a written exam (Klausur; essay exam, no multiple choice, without the use of learning aids, 100 % of the grade; 90 min): The written exam assesses how well the students remember the theoretical background, can judge plant stress parameters and interpret data from original literature. Additionally, students are assessed for their ability to translate the obtained knowledge and literature work to a new topic in plant stress physiology, e.g. by designing an experimental setup to measure plant stress.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of Plant Physiology at the B.Sc. level

Content:
Definition, symptoms and physiology of stress in crop and model plants (e.g. barley, tomato, Arabidopsis thaliana). Influence of diverse biotic and some abiotic stress factors on development, hormone homeostasis, and physiological parameters of plants (e.g. chlorophyll fluorescence, oxidative stress, stress hormonal status). Plant stress signaling and effector molecules (reactive oxygen species, plant secondary metabolites, volatile organic compounds), perception of stress signals and signal transduction for stress adaptation. Relevance of diverse plant stresses for plant performance in agroecological context. Theoretical introduction into selected methods of plant stress physiology. Parameters of plant resilience under stress conditions. In discussion parts, lecturers link specific plant stress responses and stress resistance to agricultural production systems and value their agroeconomic relevance.

Intended Learning Outcomes:
Upon completion of the module, students are able to remember theoretical background and definitions of plant stress physiology. They know, are able to understand and interpret plant stress parameters. Students gain the ability to collect new theoretical knowledge and understand key assays to judge the severity of plant stress. They are able extract key findings from plant stress physiology literature and can critically interpret and value data. This enables students for understanding the experimental design and results of comparative studies on plant stress, which is relevant for example in phenotyping of experimental plant populations or breeding populations of crop plants.

Teaching and Learning Methods:
In the lecture students gain knowledge about theoretical background, definitions, kinds, physiology and relevance of plant stress and innovations in assessment and measurement of plant stress physiology. In the seminar, students are guided to critically read original research papers, condense key findings and present recent findings in the field. They learn to understand and critically interpret original work and current hypotheses in plant stress physiology. Discussions on lectures and student presentations support reflection of contents at a higher scale (e.g. from cell to plant organ, from plant organ to whole plant, from plant to field, from field to yield).

Media:
PowerPoint

Reading List:
Reviews and original research papers are provided
BB Buchanan, W Gruissem, RL Jones: Biochemistry and Molecular Biology of Plants. Wiley, 2015, 2nd Edition
R. Oliver et al.: Plant Pathology. Elsevier, 2024, 6th Edition

Responsible for Module:
Hückelhoven, Ralph; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Animal Production Systems | Tierproduktionssysteme

Module Description

WZ0034: Reproduction Biotechnology of Farm Animals | Biotechnologie der Reproduktion von Nutztieren

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination performance is given in the form of an oral individual examination (20 min.). The students should be able to apply the various standard methods of reproductive biotechnology for pigs, cattle, small ruminants and poultry and to transfer them to current problems. The results of the experiments performed independently during the practical course will be discussed in a differentiated manner during the oral examination. Furthermore, the students should prove that they can answer questions on the application of the practiced experimental methods and put the results in the context of standard methods of reproductive biotechnology.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful BSc degree in Agricultural Science, Molecular Biotechnology, Biology or equivalent.

Content:
The module teaches the basics of reproductive technology especially in livestock such as swine, cattle, small ruminants and poultry. Topics such as sexing, embryo transfer, reproductive physiology, in vitro culture, preservation of embryos and sperm will be taught. In the literature seminar, recent publications in which the techniques discussed (sexing, conservation of species, manipulation of the genome, animal breeding, etc.) have been applied will be discussed. In the practical exercise, students will have the opportunity to apply some of the theoretically learned technology (e.g. sperm evaluation and conservation, microinjection, shearing, anatomy).

Intended Learning Outcomes:
After successful participation in this module, students will have in-depth knowledge of the fundamentals of reproductive biotechnology, particularly in farm animals.
After successful participation, students will be able to:
- understand early embryonic development and basic principles of molecular developmental biology in the early embryo.
- discuss standard methods of reproductive biotechnology for swine, cattle, small ruminants and poultry
- understand techniques such as sexing, in vitro embryo production and reproductive cloning
- evaluate the changing societal demands on primary animal production (e.g., animal welfare, new diets, and more) and consider them in the design of agricultural systems
- evaluate the potential of agricultural innovations for sustainable primary production of animal foods
- apply methods of embryology (e.g. anatomy), reproduction (e.g. sperm preservation and evaluation), genome modification and gene analysis (e.g. sexing PCR) in the laboratory independently (under guidance).

Teaching and Learning Methods:
The module consists of lecture, literature seminar and exercise. In the lecture, the basics of reproductive biotechnology are taught. In the literature seminar, the knowledge acquired is deepened on the basis of current publications and application examples are discussed on the basis of research results. In a subsequent exercise, the students can apply the theoretically taught techniques independently under guidance.

Media:
PowerPoint

Reading List:
Vorlesunsgunterlagen/Skript; Physiologie der Haussäugetiere; aktuelle Publikationen; Transgenic Animal Technology: A Laboratory Handbook by Carl A. Pinkert; Tier-Biotechnologie von Hermann Geldermann
Lecture notes/script; Physiology of Domestic Mammals; recent publications; Transgenic Animal Technology: A Laboratory Handbook by Carl A. Pinkert; Animal Biotechnology 1 by Heiner Niemann.

Responsible for Module:
Schusser, Benjamin; Prof. Dr.med.vet.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1048: Nutrition and Metabolism | Ernährung und Leistungsstoffwechsel

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer individuellen, 25-30 minütigen mündlichen Prüfung erbracht. In dieser wird anhand einer Beispiel-Studie abgefragt, inwieweit die funktionellen Zusammenhänge zwischen der speziellen Ernährungsphysiologie, der Nährstoffversorgung und der Leistungsfähigkeit Lebensmittel liefernder warmblütiger Nutztiere verstanden worden sind und aktuelle wissenschaftliche oder praxisrelevante Problemstellungen beurteilt und gelöst werden können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreicher Abschluss des Bachelorstudiengangs Agrar- und Gartenbauwissenschaften (agrarwissenschaftliche Orientierung) der TUM oder äquivalenter Abschluss.

Content:
Monogaster: vertiefte ernährungsphysiologische Aspekte der Nährstofftransformation bei Schwein, Pferd und Huhn; leistungsorientierte Fütterung von Zuchtsauen im Verlauf des Produktionszyklus; Fütterung und Gesundheit in der Ferkelaufzucht; Fütterungsstrategien und Produktqualität in der Ernährung von Mastschweinen sowie von Mastbroilern und Legehennen, typische erährungsbedingte Erkrankungen
Wiederkäuer: Funktionalität des Nährstofftransformators Pansen; spezielle Fütterungsaspekte der Milchkuh, von Kälbern und Aufzuchtrindern, Interaktionen zwischen Ernährung und Gesundheit.

Intended Learning Outcomes:
Nach Absolvierung der Modulveranstaltungen sind die Studierenden in der Lage, anhand von aktuellen wissenschaftlichen Veröffentlichungen die spezifischen Anforderungen einer

leistungsorientierten Ernährung landwirtschaftlicher Nutztiere (Monogaster: Schwein und Huhn; Wiederkäuer: Rind) zu erklären, praxisrelevante Ernährungssituationen und Studienergebnisse zu bewerten und Lösungsansätze für eine leistungsgerechte Fütterung zu entwickeln.

Teaching and Learning Methods:
Das Modul besteht aus zwei präsentationsgestützten Lehrveranstaltungen je Woche, von denen sich eine mit Wiederkäuern, die andere mit monogastrischen Nutztieren (Schwein, Pferd, Geflügel) beschäftigt. Damit sollen die Unterschiede in den Verdauungssystemen und die daraus resultierenden unterschiedlichen Herausforderungen klar voneinander abgegrenzt, aber auch vergleichbar gemacht werden. Fachspezifische Fragestellungen werden durch jeden einzelnen Studierenden anhand wissenschaftlicher Publikationen erarbeitet, als Kurzreferat präsentiert und in Seminarform diskutiert.

Media:
PowerPoint Präsentationen, Skript, Hand-out wissenschaftlicher Fachartikel

Reading List:
Kirchgessner et al.: Tierernährung. DLG-Verlag, 2011;
Jeroch et al.: Ernährung landwirtschaftlicher Nutztiere. Eugen Ulmer 2008;
Spiekers et al.: Erfolgreiche Milchviehfütterung, DLG-Verlag, 2009;
Gesellschaft für Ernährungsphysiologie: Ausschuss für Bedarfsnormen, 1995, 2000, 2001, 2006

Responsible for Module:
Steinhoff-Wagner, Julia; Prof. Dr.sc.agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Ernährung und Leistungsstoffwechsel (Vorlesung mit integrierten Übungen, 4 SWS)
Steinhoff-Wagner J, Vorndran A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1051: Genomic Animal Breeding | Genomische Tierzucht

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer mündlichen Prüfung (30 Minuten) erbracht. In dieser wird überprüft, inwieweit die Studierenden fundierte Kenntnis des Aufbaus der Nutztiergenome und der wichtigsten molekulargenetischen Methoden (z.B. Sequenzierung) sowie der bioinformatischen Anwendung demonstrieren können. Weiterhin sollen die Studierenden im Prüfungsgespräch nachweisen, dass sie populationsgenetische und -genomische Konzepte in einem tierzüchterischen Kontext interpretieren und anwenden können. Sie sollen insbesondere in der Lage sein, das Prinzip der genomischen Selektion zu erklären und die Vor-und Nachteile des genomischen Ansatzes zur Tierzüchtung zu diskutieren.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Bachelor Agrarwissenschaften oder äquivalenter Abschluss

Content:
Vorlesung:
Genome der Nutztiere,
genomische und epigenomische Marker,
genomische Kartierung und Analyse von QTL und Kandidatengenen,
genomische Selektion,
Grundlagen der Bioinformatik;
Praktikum:
DNA-Präparation,
PCR, Sequenzierung, Genotypisierung, Aufbereitung und Analyse von phänotypischen und genomischen Datensätzen.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in Lage, die Bedeutung des genomischen Ansatzes zur Tierzüchtung einzuschätzen. Die Studierenden sind in der Lage, die Genome von Nutztieren zu beschreiben, Gene bioinformatisch zu annotieren und zu charakterisieren. Darüber hinaus können sie molekulare Marker identifizieren und experimentell untersuchen. Sie verstehen die wichtigsten molekulargenetischen Methoden und können bioinformatische Methoden zur Analyse von Genomdaten anwenden.

Teaching and Learning Methods:
Die Veranstaltung ist zu gleichen Teilen als Vorlesung und Praktikum konzipiert. In der Vorlesung werden Grundkonzepte vermittelt und diskutiert. Im Praktikum führen die Studierenden im Labor des Lehrstuhls für Biotechnologie der Nutztiere unter Aufsicht molekulargenetische Arbeiten durch.

Media:
Power Point Präsentation

Reading List:

Responsible for Module:
Flisikowski, Krzysztof; PD Dr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

LS10021: Livestock Production and Global Grasslands | Livestock Production and Global Grasslands

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination of the module is carried out in the form of an individual report (4 pages excluding annex with tables and figures, word limit 2500), complemented by a presentation. The report and presentation account for 70% and 30% of the final grade, respectively.

The learning outcomes are examined with the explanation of key concepts. The report documents evidence of quantification of multiple selected metrics to assess livestock systems. The presentation is structured in slides and lasts no more than 20 min, followed by 10 min discussion, and will be scheduled within the last three weeks of the semester. The report has to be handed in at the end of the semester.

The assessment is based on the criteria below:
• Ability to conceptualise multiple threats to livestock systems by using quantitative metrics and other evidence (theoretical thinking);
• Ability identify problems and propose solutions based on scientific evidence;
• Completeness and correctness of the evidence presented in the report;
• Presentation and demonstration of the arguments included in the assessment.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic experience handling datasets and basic knowledge of R.

Content:
1) Main livestock systems of the world, trends, dynamics and threats;
2) Livestock systems, land use and climate change;

3) Introduction to global grasslands and important ecological, production and societal features;
4) Grasslands, biodiversity and livestock (theory and metrics);
5) Livelihoods and development of livestock-based agricultural systems;
6) Livestock systems and human nutrition;
7) Current methods to assess of livestock systems (Life cycle assessment (LCA), water productivity, energy efficiency, biodiversity impacts);
8) The use of multiple metrics to assess the state and performance of livestock systems;
9) Scenario analyses global grassland and livestock systems using models and metrics;
10) Local versus regional livestock system analysis (application of concepts learnt);

Intended Learning Outcomes:
Upon completion of this module, the students will be able to:

• Identify and understand key issues affecting livestock production and grasslands, and critically appraise the literature on these issues;
• Understand the economic and societal issues constraining the adoption of more environmentally sustainable livestock production;
• Discuss alternative scenarios and solutions for key environmental problems associated with livestock;
• Integrate theory, data and metrics to evaluate livestock systems performance.
• Write cogently and critically about key environmental problems associated with modern livestock systems and alternative, sustainable solutions;

Teaching and Learning Methods:
• The module will be delivered through lectures, integrated with interactive exercises to introduce theory, and guide the implemation of quantitative assessments.
• The module also includes a data handling training or refresher (1-2 weeks) to enable students to obtain and process (data mining) data from online open sources.
• Students learn how to apply concepts and methods and collaborate to solve a practical problem, produce a report and communicate findings to the class.
• Students interact with each other and the instructors both in the seminar room and online when working on their assigments.

Media:
Powerpoint slides, Moodle, Videos, Muro, Zoom etc.

Reading List:
Book on grasslands: Brian Wilsey, The Biology of Grasslands, ISBN: 9780198744528.
Book on current livestock systems: FAO. 2015. The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture, edited by B.D. Scherf & D. Pilling. FAO Commission on Genetic Resources for Food and Agriculture Assessments. Rome (available at http://www.fao.org/3/a-i4787e/index.html).
Recommended articles from peer-reviewed journals:

Phelps and Kaplan 2017 Land use for animal production in global change studies: Defining and characterizing a framework. Global Change Biol. 23, 4457-4471.
Bardgett et al. 2021 Combatting global grassland degradation. Nature Reviews Earth & Environment 2, 720–735.
Godfray et al. 2028 Meat consumption, health, and the environment. Science, 361, 243.

Responsible for Module:
Rufino, Mariana, Prof. Dr. mariana.rufino@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Grasslands and livestock systems, services and environmental and social outcomes (Vorlesung mit integrierten Übungen, 2 SWS)
Rufino M

Global livestock production, land use, metrics and future scenarios (Seminar, 2 SWS)
Rufino M, Hawkins J, Nevermann S
For further information in this module, please click campus.tum.de or here.

Module Description

LS10014: Managing Poultry Health | Managing Poultry Health

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination performance of the module will be a 20 minutes oral presentation of a research paper about a published case report. The presented case report will demonstrate the ability of the student to summarize the subject and present it to an audience. Students have to add and elaborate on the gained theoretical knowledge by choosing specific case reports, which will reflect their personal opinion and how they would manage similar problems in the future. The discussion with the tutor and the recommendations at the end of their presentations will show the importance of the problem in the field and what will they suggest to improve the health status of the animals.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of animal sciences and pathology
B.Sc. in various areas of Life Sciences including Agricultural and Horticultural Sciences

Content:
In this module, students are introduced to theoretical background regarding various aspects in poultry production that start with the hatch and breeding to the environment and technical measures. In addition, different case reports from the field will be analyzed and discussed. The students will be able to make a judgement regarding the health status of the birds and suggest alternative solutions based on the theoretical background.
The following elements will be approached during the lecture and the seminars:
- Particular features of poultry and what to consider in poultry production
- Causes of major health disorders
- Intoxications
- Disease prevention
- Important regulations for poultry production

Intended Learning Outcomes:
After successful participation in this module, students will be able to understand the important aspects required for the success of poultry production. They will differentiate between different production systems and what makes the poultry flock achieve best agricultural performances. They will be able to determine the risk associated with suboptimal management or health problems and to provide suggestions to improve the situation.

Students will understand various practical problems related to poultry production. They will evaluate the risk factors that may decrease poultry productivity. They will be able to analyze field problems and to evaluate clinical cases in a critical manner by determining their importance depending on the clinical outcome and economic impact.

Teaching and Learning Methods:
The module consists of lectures in the topic of poultry health, which will be followed by the seminars. After gaining a basic knowledge about possible problems that may face poultry health and welfare, the students will independently choose and present relevant topics related to the management of poultry health and the problems that may affect the productivity and the welfare of poultry flocks. The presented cases will be carefully discussed in groups and conclusions will be drawn.

Media:
PowerPoint presentations, round table discussions

Reading List:
Avian Immunology 2nd edition, Elsevier 2013
Veterinary Immunology 10th edition, Elsevier 2017
PowerPoint slides:
Avian Pathology: https://www.tandfonline.com/toc/cavp20/current
Avian Diseases: https://www.aaap.info/aviandiseases

Review and original literature is additionally provided.

Responsible for Module:
Sid, Hicham, Ph.D. hicham.sid@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1049: Livestock Diseases | Nutztierkrankheiten

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination takes the form of an oral examination (30 minutes). By explaining specific disease complexes, the ability to draw conclusions about parameters of animal welfare, economic efficiency and public health care and to take appropriate preventive measures should be demonstrated. Furthermore, the ability to critically reflect on current issues relating to operational and governmental action in the field of livestock diseases and hygiene should be tested.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's degree in Agricultural Sciences or equivalent

Content:
Important diseases of farm animals (cattle, pigs, sheep; causes, epidemiology, pathogenesis, symptoms, prophylaxis)
- Respiratory diseases
- Diarrheal diseases
- Reproductive diseases
- Inflammation of the mammary gland
- Technopathies
- Parasitoses
- Stable/transport hygiene
- Toxicoses
- State animal disease control
- Exercise: Differentiation of vital signs of "healthy" and "sick" farm animals.

Intended Learning Outcomes:
After successfully completing this module, students will be able to describe and recognize specific diseases. In addition, by understanding the principles of epidemiology and pathogenesis, students will also be able to deal with topics that were not covered in detail in the module. Furthermore, students are able to derive prophylactic and therapeutic measures and apply them as far as possible. In addition, they will be able to recognize and classify current information from the field of livestock diseases and adapt their actions to new requirements if necessary.
Overall, after successfully completing this module, students will be able to assess the significance of livestock diseases for animal welfare, the profitability of farms and public health.

Teaching and Learning Methods:
The module is mostly held as a lecture. In order to achieve the intended learning outcomes, activating learning methods are used in addition to the presentations to reflect on the learning content and link it to previous knowledge (processing and answering current questions from agricultural practice). Accompanying practical exercises on animals (propaedeutics, 4 attendance hours) are intended in particular to take into account the different prerequisites of the students to facilitate access to the lecture's content.

Media:
presentation

Reading List:
Heinritzi, Gindele, Reiner, Schnurrbusch: Schweinekrankheiten. Ulmer Verlag/UTB, 2006. ISBN-13: 9783825283254
Hofmann: Rinderkrankheiten. Ulmer Verlag/UTB, 2005. ISBN-13: 9783825280444

Responsible for Module:
Meyer, Karsten; Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Nutztierkrankheiten (Vorlesung, 4 SWS)
Meyer K [L], Meyer K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0033: Physiology of Growth, Reproduction and Lactation | Physiologie des Wachstums, der Reproduktion und der Laktation

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung erfolgt anhand einer 30 minütigen mündlichen Prüfung. In dieser soll nachgewiesen werden, dass ohne Hilfsmittel, die physiologischen Vorgänge bei Wachstum, Reproduktion und Laktation sowie die anatomischen und histologischen Grundlagen bei verschiedenen Nutztierarten bewerten können. Die Studierenden weisen nach, dass sie die Einflussfaktoren, z.B. durch die Umwelt, Haltung, Gesundheit oder Fütterung, auf die molekularen Regelkreise einschätzen können. Die Studierenden antworten mit eigenen freien Formulierungen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreiche Grundlagen- und Orientierungsprüfung Bachelor Agrarwissenschaften oder äquivalenter Abschluss.

Content:
Vorlesung: Wachstums- und Reproduktionsbiologie der Wirbeltiere
(Regelmechanismen, Anatomie (v.a. Skelett und Muskulatur, Zellaufbau), Morphologie, vergleichende Physiologie;
Systematik der Reproduktionshormone und Hormonrezeptoren, Wirkungsmechanismen der Reproduktionshormone, Hypothalamus-Hypophysen System, Spermatogenese;
Oogenese, Sexualzyklusregulation und Manipulation, Gravidität und Geburt;
Reproduktionsmanagement);
Exkursion(en): Milchprüfring in Wolnzach und/oder zu einer Besamungsstation.

Praktische Übung: Anatomie der Geschlechtsorgane und des Euters beim Rind. Erkennung funktionaler Veränderungen bei unterschiedlichen Phasen der Reproduktion.

Physiologie und Anatomie der Milchdrüsenentwicklung, Milchbildung und Aufrechterhaltung der Laktation, Kolostrumbildung und Bedeutung, Laktationsverlauf bei verschiedenen Spezies, Probleme in der Laktation und Euterentzündung, aktuelle Forschungsprojekte im Bereich der Milchdrüse, Milchentzug und Melktechnik.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage,
- die wesentlichen Grundprinzipien und Zusammenhänge der physiologischen Regelungen bis zum molekularen Level zu charakterisieren,
- die physiologischen Abläufe des Wachstums, der Reproduktion und der Laktation bei verschiedenen Nutztier-Spezies zu bewerten. Neben dem Schwein wird der Schwerpunkt beim Rind liegen,
- Regel- sowie Wirkungsmechanismen im Kontext Wachstum, Reproduktion und Laktation zu analysieren und zu bewerten.
- positive und negative Einflussfaktoren auf die Tiergesundheit und das Tierwohl zu analysieren.

Teaching and Learning Methods:
Das Modul setzt sich primär aus Vorlesungen (80%), sowie einer Vorlesung mit integrierter Übung zusammen. Letztere umfasst neben der Vorlesung eine Exkursion (10%) sowie praktischen Übungsstunden (10%).
Die Vorlesungen sollen die komplexen Regelkreise der Physiologie bis auf die molekulare Ebene erklären und lehren.
Eine Exkursion zum Milchprüfring Bayern und zu einer Besamungssation gibt den Studierenden aktuelle Einblicke in die gesetzlich vorgeschriebene Überwachung der Milch für den menschlichen Verzehr und über die Bedeutung der Fortpflanzungshygiene.
Die praktische Übung am Euter sowie den präparierten Geschlechtsorganen vertieft das Verständnis für den anatomischen Aufbau und die physiologische Funktion des Gewebe.

Media:
Präsentationen, Skripten

Reading List:
Friedemann Döcke "Veterinärmedizinische Endokrinologie", Gustav Fischer Verlag Jena, Stuttgart 1994, ISBN 3-334-60432-2

Responsible for Module:
Pfaffl, Michael; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Laktationsphysiologie (Vorlesung mit integrierten Übungen, 2 SWS)
Pfaffl M, Kliem H

Wachstums- und Reproduktionsbiologie (Vorlesung, 2 SWS)
Pfaffl M, Thaqi G

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1052: Quantitative Genetics and Design of Animal Breeding Schemes | Quantitative Genetik und Zuchtplanung

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfung wird als mündliche Einzelprüfung mit einer Dauer von ca. 30 Minuten durchgeführt. In der Prüfung soll nachgewiesen werden, dass die Konzepte der quantitativen Genetik und Zuchtplanung und die Zusammenhänge zwischen den einzelnen Elementen verstanden werden. Die Studierenden sollen Zuchtwertschätzmethoden und praktische Zuchtprogramme beurteilen und die Zweckmäßigkeit züchterischer Maßnahmen an konkreten Fallbeispielen bewerten können.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Die Studierenden sollten über grundlegende statistische Kenntnisse verfügen, die Mendelschen Vererbungsregeln kennen und über Schulkenntnisse einfacher Wahrscheinlichkeitsrechnung verfügen.

Content:
Das Modul umfasst die quantitative Genetik, die Zuchtwertschätzung, Zuchtprogramme sowie die Untersuchung praktischer Implementierungen von Leistungsprüfung und Zuchtwertschätzung.

• Vererbung an einem einzelnen Genort und Hardy-Weinberg Gesetz
• Züchtung mit einzelnen Genen
• Ähnlichkeit von Verwandten, Erblichkeit von Merkmalen und additiv-genetische Varianz
• genetische und umweltbedingte Beziehungen zwischen verschiedenen Merkmalen
• Grundprinzipien der Zuchtwertschätzung
• Vergleich verschiedener Methoden zur Zuchtwertschätzung (Index, BLUP, genomische Selektion)
• Nebenaspekte der Zuchtwertschätzung (Sicherheit, Phantomeltern, Validierung)

• Zucht auf mehrere Merkmale
• Elemente eines Zuchtprogramms und deren Zusammenspiel
• Leistungsprüfungen in der Tierzucht
• Zuchtwertschätzung in der Praxis
• Zuchtmethoden für Reinzucht und Kreuzung

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an diesem Modul sind die Studierenden in der Lage,
• wichtige Begriffe der quantitativen Genetik zu kennen, die Gesetzmäßigkeiten der quantitativen Genetik auf praktische Beispiele anzuwenden und die Zweckmäßigkeit züchterischer Maßnahme zu bewerten
• die Elemente eines Zuchtprogramms sowie die Bestimmungsfaktoren des Zuchtfortschritts und deren Zusammenwirken zu verstehen
• die verschiedenen Methoden der Zuchtwertschätzung sowie deren Vor- und Nachteile zu beurteilen und Zuchtwertschätzverfahren für Planungsbeispiele zu entwickeln
• die verschiedenen Zuchtmethoden und deren Vor- und Nachteile anhand von Fallbeispielen zu evaluieren

Teaching and Learning Methods:
• die grundlegenden Inhalte werden im Rahmen einer stark dialogorientierten Vorlesung vermittelt
• die Vorlesung wird ergänzt durch die selbständige Bearbeitung von Fallbeispielen (ein exemplarisches Datenmaterial, auf das die verschiedenen Methoden der Zuchtwertschätzung angewendet werden) und Übungsaufgaben mit gezielten Verständnisfragen zu den Ergebnissen verschiedener Zuchtwertschätzverfahren
• die Methoden der Zuchtwertschätzung werden durch praktische Programmierübungen in SciLab gefestigt
• durch Selbststudium (Arbeitsauftrag für Internetrecherche) erarbeiten sich die Studierenden Kenntnisse über die Praxis von Zuchtwertschätzung und Leistungsprüfungen in Bayern

Media:
Videoclips, Foliensätze und Übungsaufgaben auf Moodle

Reading List:
Skriptum zur Vorlesung

Responsible for Module:
Schusser, Benjamin; Prof. Dr.med.vet.

Courses (Type of course, Weekly hours per semester), Instructor:
Quantitative Genetik und Zuchtplanung (Vorlesung, 4 SWS)
Götz K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0037: Systems of Livestock Farming | Tierhaltungssysteme

Version of module description: Gültig ab summerterm 2022

Module Level:	Language:	Duration:	Frequency:
Master	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	90	60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer mündlichen Prüfung (30 Min.) erbracht. Dabei ist ohne Verwendung von Hilfsmitteln nachzuweisen, dass die funktionalen Zusammenhänge von Tierhaltungssystemen und verhaltensbiologischen Grundlagen einschließlich Verhaltensinventar und Befindlichkeiten von Nutztieren eingeschätzt und bewertet sowie Ansätze für innovative Konzepte in der artgerechten Tierhaltung entwickelt werden können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreiche Grundlagen- und Orientierungsprüfung Bachelor Agrarwissenschaften oder äquivalenter Abschluss

Content:
Der Inhalt des Moduls Tierhaltungssysteme umfasst folgende Bereiche:
• Verhaltensbiologische Grundlagen (Regulation und Ontogenese des Verhaltens, fachübergreifende Verhaltensgenetik und -physiologie, Normalverhalten und Verhaltensabweichungen, Lernverhalten, Befindlichkeiten und Tierschutz).
• Verhaltensinventar der verschiedenen Nutztierarten (Rinder, Schweine, Pferd, Geflügel) einschließlich Konsequenzen für eine artgemäße Haltung.
• Konstruktionsziele und zielorientierte Auswahl tierischer Produktionssysteme
• Verfahrenstechnische Strategien
• prozessbasierte Mess- und Regelungssysteme
• prozessorientierte Strukturierung der Verfahrenstechnik

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden sind in der Lage, Systeme in der Tierhaltung (für z.B. Rinder, Schweine, Pferd, Geflügel) selbständig zu analysieren, diese zu bewerten und daraus zukünftige Systemansätze zu entwickeln. Sie können die verhaltensbiologischen Grundlagen analysieren und bewerten. Sie sind in der Lage, nutztierartspezifisch das arttypische Verhalten einschließlich der Konsequenzen für eine artgemäße Haltung kompetent zu charakterisieren und zu überprüfen.
Darüber hinaus sind die Studierenden sind in der Lage, prozessbasierte Mess- und Regelungssysteme, prozessorientierte Strukturierung der Verfahrenstechnik zu verstehen, sowie verfahrenstechnische Strategien und Konstruktionsziele für tierische Produktionssystem zielorientiert auszuwählen und zu bewerten. Auf dieser Basis sind die Studierenden befähigt moderne artgerechte Tierhaltungssysteme zu entwickeln.

Teaching and Learning Methods:
Die Lehrveranstaltung umfasst zwei Lehrveranstaltungen zu den Teilbereichen Verhaltensbiologie und Tierhaltungssysteme. In power point-gestützten Vorlesungen werden jeweils die Grundlagen über die Verhaltensbiologie und die Analyse von Tierhaltungssystemen erarbeitet, die dann im Rahmen von studentischen Vorträgen in Form von Präsentationen in Gruppenarbeit angewendet und beispielsweise auf besondere Aspekte wie die Befindlichkeiten von Nutztieren und des Tierschutzes vertiefend bearbeiten werden können. Bestehende Tierhaltungssysteme werden auf Basis von Vorlesungen und Gruppenarbeiten analysiert. Dabei ist vorgesehen, dass in der Vorlesung an Beispielen die Analyse erläutert wird. In den anschließenden Gruppenarbeiten sollen die Kenntnisse an anderen Tierhaltungssystemen eingeübt und hinterfragt werden.

Media:

Reading List:
Kappeler, P. "Verhaltensbiologie"; 2006; Hoy, S. und Mitarbeiter "Nutztierethologie"; 2008; Eugen Ulmer Verlag; Jensen, P. "The Ethology of Domestic Animals"; CAB International, 2009; Ekesbo, E. "Farm Animal Behaviour"; CAB International, 2011; Jungbluth, T., Büscher, W., Krause, M. "Technik Tierhaltung" 2017

Responsible for Module:
Bernhardt, Heinz; Prof. Dr. agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Tierhaltungssysteme (Vorlesung, 4 SWS)
Bernhardt H [L], Bernhardt H, Reiter K, Zeitler-Feicht M, Zeiler E
For further information in this module, please click campus.tum.de or here.

Agroecosystems | Agrarökosysteme

Module Description

LS10002: Introduction to Modelling of Agroecosystems | Einführung in die Modellierung von Agrarökosystemen

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination takes place orally as part of an individual examination. The planned duration of the examination is 30 minutes.
In the examination, students should demonstrate, without aids, that they are able to characterize the fundamentals of the mathematical formulation of crop models and their application in a differentiated manner. To this end, the exercise's methodological knowledge must be transferred to other crops using selected model systems/approaches. The influence of various agronomic factors on the modeling must be explained. Students demonstrate that they can apply and evaluate the methods for model evaluation.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of agricultural sciences

Content:
Introduction to the calculation of the water balance of terrestrial ecosystems on different spatial and temporal scales. Introduction to the basic concepts and (measurement) methods of soil hydrology (water content, matrix potential, hydraulic soil characteristics, Darcy-Buckingham water flow, river boundary conditions, groundwater levels) and the approaches to mathematical modeling of soil water flow. Principles for characterizing, measuring and modelling the transport of chemicals with the soil solution (especially urea, ammonium, nitrate, pesticides). Model description of land management (tillage, sowing, fertilization, irrigation, mulching, harvesting).
Introduction to modeling and various models of soil organic matter turnover and decomposition.

Basics of modeling plant growth processes (photosynthesis, allocation, respiration, maintenance respiration, phenological development, transpiration, root growth, crop development, aging) for different crop species (e.g., wheat, barley, maize, rape, potato, sugar beet, catch crops), taking into account varietal differences.

Intended Learning Outcomes:
After successfully completing the module, students will be able to
- fundamentally understand the formulation of mathematical models of physical, chemical, and biological processes to describe the growth of crop systems
- fundamentally understand the formulation of mathematical models of transport processes of water and nitrogen in soils, as well as of turnover processes of organic soil substances
- describe the structure of system models for the simulation of agricultural production systems
- evaluate the most important growth models of the most important crops and variety parameterization
- evaluate the simulation of agricultural production systems for different locations using different fertilization strategies
- apply growth models to different climatic conditions
- develop new approaches to growth models.

Teaching and Learning Methods:
The basics of plant growth models are examined based on lectures, and existing simulation approaches are analyzed. Exercises, which take place in dialog with the students, are intended to enable students to actively engage with plant growth models themselves. This should ensure that students not only understand the basics but can also apply them themselves. In this course, the models will be evaluated for the most important agricultural crops and changing climatic conditions, and new approaches will be developed.

Media:
presentations

Reading List:
Provided via "moodle"!

Responsible for Module:
Asseng, Senthold; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1065: Climate Change and Agriculture | Klimawandel und Landwirtschaft

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer schriftlichen Prüfung erbracht (Klausur, 90 Minuten). Hierbei müssen die Studierenden Kontext- und Fachfragen beantworten, die von den verschiedenen Vortragenden gestellt werden.
Die Studierenden weisen nach, dass sie die vielfältigen Themen aus der Ringvorlesung (Klimatologie, Pflanzen-/Tierproduktion, Ökonomie, Maßnahmen) analysieren und bewerten sowie im Kontext agrarischer Produktionssysteme diskutieren können. Hilfsmittel sind nicht vorgesehen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen der Agrarwissenschaften

Content:
Die Modulveranstaltung orientiert sich an der Struktur des Intergovernmental Panel on Climate Change (IPCC).
Das IPCC erarbeitet als ‚Weltklimarat‘ für politische Entscheidungsträger den Stand der wissenschaftlichen Forschung hinsichtlich des Klimawandels, erstellt Prognosen über die Auswirkungen und zeigt Möglichkeiten zur Bekämpfung der globalen Erwärmung auf.
Das Modul folgt dabei den drei Arbeitsgruppen des IPCC und lädt zu jedem Themenbereich Gastvortragende ein.
Diese kommen aus verschiedenen Forschungsgruppen der TUM, der Ludwig-Maximilians-Universität sowie aus der Wirtschaft und Politik.
Der Hauptfokus liegt auf den Auswirkungen auf die landwirtschaftliche Produktion und Ökologie.
Der Aufbau des Modules ist:

1. Naturwissenschaftliche Aspekte des Klimawandels:
- u.a. wodurch entsteht die globale Erwärmung, wie hängen Klima und Wetter zusammen, welche Daten lassen sich messen

2. Auswirkungen des Klimawandels:
- Effekte auf die Pflanzenproduktion, Adaption durch Pflanzenzüchtung, Modellierung von Zukunftsszenarien, Emission- und Reduktion durch die Tierhaltung, Risikokalkulation in der Ökonomie

3. Möglichkeiten zur Minderung des Klimawandels
- Abschwächung des Klimawandels in Entwicklungsländern, Negative Emissionen zur Reduktion der Treibhausgase, Standpunkte der Politik sowie von Landwirtschaftsvertretern

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage:

- Die physikalischen Grundlagen des Klimawandels darzustellen
- Auswirkungen des Klimawandels auf die Pflanzen- und Tierproduktion sowie natürliche ökologische Systeme auf regionaler sowie globaler Ebene zu analysieren
- Ökonomische Konsequenzen der globalen Erwärmung zu beurteilen
- Maßnahmen zur Adaption und Abschwächung des Klimawandels zu bewerten

Des Weiteren hat sich jeder Studierende intensiv mit einem individuellen Thema befasst und kennt in diesem Bereich den aktuellen Stand der wissenschaftlichen Forschung und kann diesen in Kontext mit agrarischen Produktionssystemen diskutieren.

Teaching and Learning Methods:
Die Vorlesung findet als Ringvorlesung statt, die sich thematisch an den Themen des für den Forschungsberichtes des Interovernmental Panel on climate change (IPCC) orientiert und den Studierenden einen umfassenden Überblick über den aktuellen Forschungsstand in der agrarbezogenen Klimaforschung liefert.

Media:
Vorträge, Präsentationen

Reading List:
Handzettel zur Unterstützung der Präsentationen, Fallbeschreibungen

Responsible for Module:
Asseng, Senthold; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Klimawandel und Landwirtschaft (Vorlesung, 4 SWS)

Asseng S [L], Asseng S, Bassu S, Cabernard L, Geist J, Henkel M, Herz M, Hoheneder F, Hülsbergen K, Mennig P, Menzel A, Seitz F, Villalba Camacho R, Wiesmeier M
For further information in this module, please click campus.tum.de or here.

Module Description

LS10032: Livestock-Plant-Soil Interactions & Nutrient Cycling | Livestock-Plant-Soil Interactions & Nutrient Cycling

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination of the module will be in the form of a laboratory assignment. The student will conduct a six-week, full-time practical course in research/ research project, implementing a set of simple experiments (2-3) independently, and under close supervision.

After completion of the experimental work, the student will write a report of a maximum of 10 pages (A4, 5000 words), handed in within 8 weeks after completion of the experimental work. This report has to demonstrate the student's ability to summarise theory, set aims for the research, present results concisely and coherently, and interpret and discuss the experimental data in the context of the literature.

The grade will be based on the quality of the data analysis (50%) and of the data presentation (50%). For the presentation, the evaluation will be based on whether the theoretical background is properly described, the data presentation is of high standards, the calculations and application of statistical tests are accurate, and the results are interpreted and discussed appropriately.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of Plant and Soil Science, notions of Animal nutrition.

Content:
Domestic livestock plays a major role in nutrient cycling of managed ecosystems. Grazing can alter the plant species community and influence the rate of turnover of major nutrients, creating multiple cascading effects. Livestock can for example, increase the the input of labile carbon and nitrogen into topsoils, which can result in increased nutrient losses to the environment, also as

greenhouse gases (GHG). The presence of grazing livestock can also modify how plants interact with soil microbes, promoting in some cases carbon storage or increasing losses in some other cases. This can be heavily influenced by livestock management practices, such as: animal density, grazing times, handling of animal manures, and supplementary feeding.

This module is designed to provide the student research tools to improve their understanding of the factors controlling nutrient cycling in livestock systems and the key interactions between animal-plant-soil. This knowledge is required to reduce environmental impacts from livestock production and also to support the health of grazed ecosystems.

The student will learn a subset of the following techniques:
+ Designing experiments to assess nutrient stocks and flows in grazed ecosystems (grasslands, woodlands).
+ Sampling biomass, determining plant species, assessing nutrient stocks and flows.
+ Conducting manipulation (micro and meso-scale) experiments to test hypotheses about nutrient cycling in grazed ecosystems, and altered climatic conditions (drought, flooding, increased temperatures).
+ Performing laboratory analyses of organic and inorganic fractions of carbon, nitrogen, and phosphorous in soils and animal manures, using a combination continuous flow analyses, and high temperature catalyical combustion.
+ Measuring ecosystem net gas exchange using infra red gas analysers and canopy assimilation chambers.
+ Measuring trace gases fluxes using Optical Feedback-Cavity Enhanced Absorption Spectroscopy (OF-CEAS) under controlled conditions and in the field.
+ Measuring plant traits in grazed ecosystems, in response to grazing in the field or in controlled environments.

Intended Learning Outcomes:
Upon completion of this module, the students are able to:

- Define a researchable topic applying a pragmatic experimental research methodology specific to livestock-based agricultural systems,
- Conduct experiments competently in the field and laboratory using specialised equipment, and applying rigorous scientific methods,
- Integrate theory, research data, and analyses to test hypotheses relevant to livestock systems,
- Communicate effectively research findings in formats appropriate for an academic audience.

Teaching and Learning Methods:
The student will conduct a six-week, full-time practical course in research/ research project, implementing a set of simple experiments (2-3) independently, and under close supervision.

The schedule of the field and lab work can be adjusted according to the student’s curriculum.

Discussion of theory and experimental approaches combined with independent lab and field work will enable the student to understand and implement simple experiments to study animal-plant-soil interactions. By discussing research protocols, the student will analyse the methodological principles of the research. Consulting research articles will help the student learn how to assess quality standards in field and lab research. Writing a research report will support learning how to present results and discuss them in the context of the relevant literature.

Media:
Powerpoint slides, TUM Moodle, Videos, Muro, Zoom etc.

Reading List:
Amundson, R. 2021 Introduction of Biogeochemistry of Soils. Cambridge University Press. 222p
Wilsey, B. 2018. The Biology of Grasslands. Oxford Academic. 195p
Frauendrorf, TC et al., 2021. Animal legacies lost and found in river ecosystems. Env Res Letters 16, 115011

Responsible for Module:
Rufino, Mariana, Prof. Dr. mariana.rufino@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Livestock-plant-soil interactions & nutrient cycling (Forschungspraktikum, 10 SWS)
Rufino M, Nevermann S, Sibilu H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1067: Soil Protection in Agricultulture | Landwirtschaftlicher Bodenschutz

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer 120-minütigen Klausur - ohne Hilfsmittel - erbracht. In der Klausur weisen die Studierenden nach, inwiefern sie Landnutzung und Bodenfunktionen und -prozesse in Beziehung zueinander setzen und beurteilen können. Sie sollen in eigenständig formulierten Antworten ausführen, dass sie die Verknüpfung von Gefährdungen von landwirtschaftlichen Böden in Bezug zu Bodeneigenschaften setzen können. Sie müssen in der Lage sein, auf Grundlage der in den Geländeübungen erworbenen Kenntnisse praxisrelevante Fragen zur Auswirkung landwirtschaftlicher Nutzung zu beurteilen. Die Studierenden analysieren selbständig die Auswirkungen landwirtschaftlicher Bodennutzung und entwickeln daraus mögliche nachhaltige Bodennutzungen und Schutzkonzepte.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Soil science (WZ1825) or comparable courses at other universities

Content:
Problems of soil protection and soil degradation in temperate agricultural production systems.
Soil functions and their interrelationship with environmental factors and their sustainability, legislation in Germany, and policy framework in Europe. Erosion processes and agricultural measures to reduce them.
Impairment of soil physical processes and air and water balance through compaction. Humus balance of agricultural soils, plant cultivation, and agricultural engineering measures and strategies for using organic fertilizers.
Soil protection aspects of nutrient management and reciprocal environmental relationships, especially of nitrogen and phosphorus.

The formation of greenhouse gases, agricultural use of peat soils, and political connections.
Material inputs and possible hazards from heavy metals, pesticides and microplastics in soils.
Cross-disciplinary interactions of material hazards within agricultural production systems.
Soil ecology, biological soil functions and effects on soil fertility. Field exercises on selected agricultural production systems in order to assess soil protection aspects (e.g. effects of machine use and different crop rotations on soil properties, especially soil physical condition, carbon storage and yield performance) and to learn soil sampling methods.

Intended Learning Outcomes:
After successfully completing the module, students will be able to assess the diverse soil functions (e.g. yield function, filter function) and evaluate the material and non-material hazard potential of soils in agricultural production systems. They are able to understand soil functions of agriculturally used soils with reference to basic physical, chemical, and biological soil properties and processes and to classify interrelationships with plant and animal production systems as well as the environment and society. Building on the lectures and exercises, students can independently assess soil properties (e.g. structure) and deduce how these have a lasting effect on the soil as a protected resource through agricultural measures (e.g. interseeding, green manure, no-till farming). Students can holistically identify the reciprocal influences and interactions of soils with other utilization aspects of agricultural production systems and establish interdisciplinary links.

Teaching and Learning Methods:
The basics of soil functions and processes are taught in the lecture. The application is consolidated and deepened in three field exercises. Agricultural practices (e.g., use of machinery, crop rotation) are presented, and students are taught how to assess and evaluate soil properties in the field.

Media:
Presentations

Reading List:
Presentations, in-depth book list on request

Responsible for Module:
Schweizer, Steffen; Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Landwirtschaftlicher Bodenschutz (mit integrierter Übung) (Vorlesung mit integrierten Übungen, 4 SWS)
Schweizer S [L], Schweizer S, Just C, Völkel J, Zare M, Hafner B, Wiesmeier M, Walter R
For further information in this module, please click campus.tum.de or here.

Module Description

LS20023: Soil and Plant Hydrology | Soil and Plant Hydrology

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

This module requires students to complete a graded seminar presentation and submit an accompanying extended summary on a chosen topic to demonstrate a solid understanding of topics discussed in the lectures. The oral presentation should be a 15-20-minute presentation, followed by a 30-minute discussion session to showcase the student's ability to respond effectively to any questions or discussions related to their subject matter. The extended summary should be a minimum of 5 pages and will be evaluated using the criteria outlined in a template provided during the lecture. The presentation is scheduled to take place during the last three weeks of the semester, and the extended summary must be submitted by the end of the semester. The oral presentation (counts for 30% of the final grade) is a prerequisite for the submission of the extended summary (counts for 80% of the final grade).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
Upon completion of this module, students will have an understanding of the principles of soil and plant water relations. This includes studying the physics of water flow across various components of the soil-plant-atmosphere continuum such as soils, the rhizosphere, the root system, xylem, and leaves. Additionally, students will be introduced to various techniques for quantifying water flow across these key elements. In the end, students will be encouraged to discuss the potential of different soil and plant traits impacting plant drought tolerance under water and nutrient deficit condition.

Intended Learning Outcomes:
This module is designed to provide students with a comprehensive understanding of the complex relationships between soil, plant, and water. Upon successful completion of this module, students will be able to:
1) Discuss the principle of water flow across soil-plant-atmosphere continuum.
2) Discuss potential mechanisms plants use to cope with drought stress, and how these mechanisms vary depending on the soil and climatic conditions. Indeed, how plants can adapt to different soil conditions, and how this adaptation affects their ability to tolerate drought stress.
3) Mechanistically describe/predict various physiological and anatomical adaptations that can improve plant access to soil resources under drying conditions.
4) Understand the state-of-the-art research in soil and plant hydrology in the context of drought stress.

Teaching and Learning Methods:
The lecture on soil-plant hydrology will be a 2-hour session held weekly, where students will be introduced to the principles of water flow through the soil-plant-atmosphere continuum, starting from an individual single root and extending to the plant and canopy scales.
The lecture will consist of a combination of PowerPoint presentations and demonstrations on the whiteboard. The PowerPoint slides will be made available to students before each lecture.
For the seminar part, students will be introduced to the latest research and discussions in the field of soil-plant-water relationships and potential strategies to cope with drought stress. Each student will choose a topic from a list of options, conduct a literature review, and prepare an oral presentation and an extended written summary. Students will be offered individual one-to-one meetings to guide them in the preparation of their oral presentation and extended summary.

Media:

Reading List:

Responsible for Module:
Zare, Mohsen, Prof. Dr. mohsen.zare@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar on Water, nutrients and carbon exchange across soil-plant-atmosphere continuum (Seminar, 2 SWS)
Zare M [L], Hafner B, Zare M

Soil plant water relationship (Vorlesung, 2 SWS)
Zare M [L], Zare M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0121: Environmental Conserving Fertilization Systems | Umweltgerechte Düngesysteme

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird schriftlich (Klausur, 120 min) erbracht. Dabei soll nachgewiesen werden, dass ohne Hilfsmittel Zusammenhänge zwischen Standortbedingungen, Nährstoffumsatz und umweltgerechtem Einsatz von Düngemitteln verstanden sowie strukturiert und komprimiert wiedergegeben werden können. Probleme aus dem Gebiet des umwelt- und standortgerechten Einsatzes von Mineralstoffen sollen benannt, Wege zu einer Lösung aufgezeigt und auf wissenschaftlicher Basis begründet werden. Die Beantwortung der Fragen erfordert eigene Formulierungen.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Grundlagen der Pflanzenernährung und der Bodenkunde
Grundlagen des Pflanzenbaus und Kenntnisse der Produktion landwirtschaftlicher Kulturen

Content:
Das Modul befasst sich mit dem standortangepasstem Einsatz von Nährstoffen unter dem Gesichtspunkt möglichst hoher Umweltverträglichkeit und mit dem Ziel der Erhöhung der Nährstoffeffizienz.
Hierbei spielen insbesondere eine Rolle: Variabilität von N im Boden, Nährstoffvariabilität in organischen Düngern, charakteristische Eigenschaften von mineralischen und organischen Düngemitteln im Kontext von Standorteigenschaften.
Hierbei geht es vor allem um Stickstoff, Kalium, Phosphat, Schwefel, Kalk und Spurennährstoffen, sowie um die Bedeutung von Wasser als Produktionsfaktor.

Intended Learning Outcomes:
Nach Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage,
- Nährstoffvariabilität in Böden und organischen Düngern zu bewerten,
- den Nährstoffumsatz (Nachlieferung, Mobilität, Verluste) in Abhängigkeit von Standortbedingungen zu analysieren,
- Wirkung und Umsatz von organischen und mineralischen Düngern zu bewerten und deren standortgerechten Einsatz zu analysieren
- umweltgerechte Düngesysteme hinsichtlich ihrer Nährstoffeffizienz auf verschiedenen Standorten abzuleiten und zu bewerten
- die Bedeutung des Standortfaktors Wasser für die Produktivität zu analysieren

Teaching and Learning Methods:
Das Modul besteht aus einem Vorlesungsteil, der der Vermittlung von Wissen dient, und unmittelbar begleitend dazu, einem Übungsteil, in dem Studierende dieses Wissen vor Ort in der Beurteilung von Pflanzenzuständen in Feld- und Gefäßversuchen unter Anleitung anwenden.

Media:
Präsentationen (Handzettel), Fallbeschreibungen

Reading List:
K. Mengel, 1991: Ernährung und Stoffwechsel der Pflanze, 7. Auflage, G. Fischer, Jena.
G. Schilling, 2000: Pflanzenernährung und Düngung, Eugen Ulmer, München.
LfL-Information, 2018: Leitfaden für die Düngung von Acker- und Grünland, 14. Auflage, Bayerische Landesanstalt für Landwirtschaft.

Responsible for Module:
Bienert, Gerd Patrick; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1344: Urban Agriculture | Urban Agriculture

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module grade is based on a written report (approx. 20 pages; 80% of grade) complemented by an oral presentation (15 min. + 5 min. discussion; 20% of grade). In the report, the students design a strategy for ecologically oriented sustainable urban agriculture. Here, students should situate their strategy in a theoretical framework, and evaluate the relevant environmental and social context of their strategy. Written summaries measure the student's understanding and evaluation of ecological and social aspects, and ability to apply theoretical frameworks. In the presentation, the students present their strategy (PowerPoint plus any additional aides) to demonstrate understanding of an urban agriculture system, communicative competence, presentation, and discussion skills in front of an audience. Students may prepare the report and project individually or as a group (max. 3 students). In the case of group work, students must report academic contribution and their performance will be evaluated individually.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge in agriculture, landscape planning, and landscape ecology is an advantage

Content:
Urban agriculture has experienced a renaissance in recent decades. What are the possibilities for sustainable urban agriculture that supports multiple ecosystem services? This module explores ways in which urban agriculture can aid in the enhancement of food security, biodiversity, energy conservation, public health and well-being in cities. We will discuss the agro-ecological basis of urban horticultural production systems adapted for city environments. Topics include fundamentals of horticulture, soil properties and fertility, pest and pollinator management, animal agriculture, and climate change impacts. The students will learn about methods of urban agriculture and innovative approaches to ecologically-oriented and climate-resilient urban agriculture. In addition,

they will study how urban food production interacts with social, cultural, and political dimensions of urban environments (e.g. city policy, economics, human health) to foster an interdisciplinary understanding.

Intended Learning Outcomes:
On successful completion of the module, participants are able to:
1. Understand important agroecological aspects of urban agriculture such as biodiversity, soil management, and climate mitigation;
2. Relate social aspects of urban agriculture to environmental aspects such as public health and urban policy;
3. Apply interdisciplinary theoretical frameworks to urban agricultural systems;
4. Evaluate the environmental and social context of urban agriculture;
5. Create a strategy for a sustainable urban agricultural system in a project;
6. Communicate their strategy with understanding and evidence.

Teaching and Learning Methods:
The module is highly interactive and combines lectures with field trips and presentations from guests and peers. The lecture series will cover topics including: fundamentals of horticulture; soil management; pest and pollinator management; urban agriculture and climate change; challenges of urban agriculture; public health; and the business of urban agriculture. The seminars are based in experiential learning. In the seminars, we will 'see' cities as edible: in the present on field trips; in the past through films and advanced readings; and in the future through group presentations that design urban farming systems for future cities.

Media:
PowerPoint, films, virtual lectures

Reading List:
Egerer, M. & Cohen, H. (2021) Urban Agroecology: Interdisciplinary Research and Future Directions. CRC Press, Boca Raton, FL.

Carpenter, N., & Rosenthal, W. (2011). The essential urban farmer. Penguin.

Zeunert, J. (2018). Dimensions of urban agriculture. In Routledge handbook of landscape and food (pp. 160-184). Routledge.

Zimmerer, K. S., Bell, M. G., Chirisa, I., Duvall, C. S., Egerer, M., Hung, P. Y., ... & Yacamán Ochoa, C. (2021). Grand challenges in urban agriculture: ecological and social approaches to transformative sustainability. Frontiers in Sustainable Food Systems, 5, 668561.

Responsible for Module:
Egerer, Monika; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Urban Agriculture (Vorlesung, 2 SWS)
Egerer M [L], Egerer M, Casanelles Abella J

Edible Cities (Seminar, 2 SWS)
Egerer M, Sexton A
For further information in this module, please click campus.tum.de or here.

Agricultural Economics | Agrarökonomie

Module Description

WI000304: Agricultural and Agri-Environmental Policy | Agrar- und Agrarumweltpolitik

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird durch eine Klausur (90 Minuten) erbracht, wobei als einziges Hilfsmittel ein nicht programmierbarer Taschenrechner zugelassen ist. Durch Rechenaufgaben und Theoriefragen wird geprüft, ob die Studierenden die Wirkungsweise von agrarumweltpolitischen Maßnahmen und ihrer wohlfahrtsökonomischer Implikationen verstanden haben, erklären und berechnen können. Zudem wird geprüft, ob die Studierenden die relative Eignung von agrarumweltpolitischen Maßnahmen analysieren und beurteilen können und auf konkrete umweltpolitische Problemstellungen transferieren können. Die Beantwortung der Fragen zur Theorie erfordert eigene Formulierungen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
BSc.; Umweltökonomische Grundkenntnisse sind von Vorteil.

Content:
Basierend auf den technisch-naturwissenschaftlichen Wechselwirkungen zwischen landwirtschaftlicher Tätigkeit und deren Umweltwirkungen wird in der Veranstaltung die relative Eignung agrarpolitischer Maßnahmen zur Überwindung von Umweltproblemen analysiert und diskutiert. Zunächst werden die der Wohlfahrtstheorie zugrunde legenden Bewertungsmaßstäbe vorgestellt und diskutiert. Im Anschluss werden die Wohlfahrtswirkungen analysiert, welche sich durch Handelsliberalisierung und Umweltpolitik im internationalen Kontext ergeben. In diesem Zusammenhang wird eine Einführung in die Spieltheorie gegeben, um eine besseres Verständnis strategischer Aspekte bei dem Umgang mit umweltpolitischen Fragestellungen zu

erlangen. Anschließend werden optimale Ansatzpunkte einer nationalen Umweltpolitik analysiert und diskutiert bevor die Wirkungsweise einzelner Politikmaßnahmen besprochen werden (Umweltauflagen, Emissionssteuern, Zahlungen für Umweltleistungen in Form differenzierter Verträge oder durch Ausschreibungen). Im letzten Abschnitt wird auf die Fragestellung eingegangen, wie die Einhaltung von Agrarumweltmaßnahmen bestmöglich gewährleistet werden kann.

Intended Learning Outcomes:
Das Modul stärkt die systemischen Kompetenzen indem die Studierenden ein umfangreiches Verständnis über die vielfältigen Wechselwirkungen zwischen landwirtschaftlicher Tätigkeit und deren Auswirkungen auf die natürliche Umwelt erlangen. Nach dem erfolgreichen Besuch des Moduls sind die Studierenden zudem in der Lage,
• die Wohlfahrtswirkungen von Handelsliberalisierung in der Gegenwart von Umweltproblemen zu analysieren
• die Bandbreite agrarumweltpolitischer Instrumente und deren Wirkungsweise zu erklären
• die relative ökonomische Eignung von agrarumweltpolitischen Instrumenten zur Reduzierung von Umweltproblemen zu analysieren und zu bewerten
• Die Wirkungsweise von agrarumweltpolitischen Maßnahmen anhand einer Modelkalkulation quantitativ abzuschätzen
• Ansatzpunkte einer optimalen Agrarumweltpolitik wohlfahrtstheoretisch zu beurteilen
• strategische Erwägungen von Umweltpolitik im internationalen Kontext mit Hilfe der Spieltheorie zu erklären

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung und einer begleitenden Übungsveranstaltung.
Eine Vorlesung ist eine geeignete Form um die zur ökonomischen Beurteilung agrarpolitischer Maßnahmen erforderlichen theoretischen Grundlagen-Kenntnisse zu vermitteln. Der Dozent erklärt die relevanten Inhalte; Rückfragen der Studenten können innerhalb der Vorlesung geklärt werden. Auf diese Weise kann sichergestellt werden, dass alle Studenten einen ausführlichen Einblick in das Thema auf demselben Niveau erhalten. Die Studierenden werden zudem zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt.
Im letzten Drittel der Veranstaltung werden Übungen im Computerraum durchgeführt bei der die Wirkungsweise unterschiedlicher agrarpolitischer Maßnahmen anhand von Modellrechnungen quantitativ abgeschätzt und in der Gruppe diskutiert wird.

Media:
Präsentationen, Excel-Übungen

Reading List:
Vorlesungsfolien und ausgewählte wissenschaftliche Literatur werden zu jedem Kapitel auf Moodle im PDF Format zur Verfügung gestellt.
Tietenberg, T. and L. Lewis (2010): Environmental Economics and Policy. Pearson.

Responsible for Module:
Glebe, Thilo; PD Dr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0038: Agribusiness Systems Analysis | Agribusiness Systems Analysis

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a project, which is divided into a written report (15-20 pages) and a group presentation (30 minutes presentation and 30 minutes questions-and-answer session). Groups consist of 4 to 6 students so that sufficient teamwork is required, but an individual contribution is still identifiable.
The written report is due at the end of the semester. Students summarize the content of their presentation and incorporate the feedback and information received during the questions-and-answers sessions in the final report.
The presentation tests the ability of students to research a particular value chain in a defined period of time in such a way that it can be presented or submitted to an audience in a clear and understandable way. Each student in a group is responsible for one part of the group’s presentation. Individual grades for each presentation are based on the quality of the presentation and the ability to address questions.
The written report tests the ability of students to completely develop the chosen topic regarding a specific value chain. Students are required to work according to guidelines for scientific work - from the analysis to the conception and the implementation. All students in a group contribute to the drafting of the final report.
The presentation contributes 60% to the final grade. The written report contributes 40% of the final grade.

Repeat Examination:

(Recommended) Prerequisites:
Undergraduate level microeconomics and industrial organization.

Content:
The module covers the economics and analysis of agribusiness systems.
The course provides an overview of the institutional framework in which the EU agro-food sector operates, and covers trends in and challenges to the functioning and performance of the agro-food sectors in the EU, USA and developing countries. The course covers economic models and conceptual frameworks required to analyse the economic effects of various challenges posed by globalization, climate change, growing consumer demand for quality and sustainable products, market power and the imbalance of power within the supply chain. The course introduces students to the EU industrial policy for the agro-food sector and discusses market-based and non-market based solutions to improve the functioning and performance of the agro-food sector, including food labelling and production, processing, and distribution standards, formal and informal coordination and alignment of incentives among different actors of the supply chain.

Intended Learning Outcomes:
After successfully completing the module, students will be able to perform an independent analysis of a modern agribusiness system. This entails being able to:
(1) describe the main components and actors, their interactions and the structure of the system
(2) describe and analyse the socio-economic context, the institutional environment and the relevant industrial policies
(3) assess the performance of the system and the distribution of generated welfare among the different actors by applying economic models and conceptual frameworks
(4) assess the effect of the institutional environment (including industrial policies) and agro-economic innovations on the functioning and performance of the system by applying economic models and conceptual frameworks
(5) find suitable market-based and non-market based solutions to improve the functioning and performance of the agribusiness system by applying economic models and conceptual frameworks
(6) conduct analysis on the economic value creation of modern agribusiness systems and present in oral form the analysis of an agribusiness system
(7) draw up a written report of the analysis of an agribusiness system

Teaching and Learning Methods:
Lectures are used to provide an overview of the institutional framework, trends and challenges faced by the agro-food sector and to cover the economic models and conceptual frameworks needed to analyse value chains. Frontal lectures are used to provide students with the needed background for the analysis of value chain(s).

Market experiments (e.g., the-market-for-lemons-class-experiment) are used to illustrate economic models and conceptual frameworks. Group work is used to train students to research and summarize information related to value chain(s) and their institutional environment, to assess the performance of value chain(s), to explain challenges to the functioning and performance of value chain(s), to find potential solutions, and to draw up a final report. In addition, student presentations and class discussion are used to train students to present their analysis in oral form and to receive and integrate feedback into a written report.

Media:
Teaching aids include: PowerPoint slides, scientific journal papers and hand-outs.

Reading List:
Scientific journal articles and official reports from public institutions (e.g., EU, USDA etc.) will be provided during the lecture.

Responsible for Module:
Menapace, Luisa; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0039: Analysis and Development of Agricultural Business | Analyse und Entwicklung landwirtschaftlicher Betriebe

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer schriftlichen Klausur von insgesamt 90 Minuten Dauer - ohne Benutzung von Hilfsmitteln - erbracht. Mit der Klausur wird überprüft, inwieweit die Studierenden die Planungs- und Optimierungssituation landwirtschaftlicher Betriebe in den natürlichen, technologischen, ökonomischen und politischen Kontext korrekt einordnen und grundsätzliche Agrarsystem bezogene Zusammenhänge einbeziehen können. Risikoquantifizierung und -management sollen schliesslich ebenso beherrscht werden wie die Analyse und Modellierung produktionsökonomischer Zusammenhänge im Betrieb.
Darüber hinaus weisen die Studierenden nach, dass sie verschiedene Rechnungssysteme zur Betriebsanalyse bewerten sowie betriebswirtschaftliche Kennzahlen ermitteln und in ihrer Aussagekraft im systemischen Kontext beurteilen können. Anhand eines strukturierten, kurz gefassten Fachaufsatzes stellen sie im Weiteren unter Beweis, dass sie die Herausforderungen existenter landwirtschaftlicher Betriebe kennen und betriebszweigspezifische Problembereiche sowie agrarsystemische Anforderungen diskutieren können. In diesem Zusammenhang wird auch überprüft, ob die Studierenden kurzfristige Rationalisierungsreserven benennen und ein tragfähiges Betriebsentwicklungsszenario für einen ausgewählten Betrieb skizzieren können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse der landwirtschaftlichen Betriebswirtschaftslehre

Content:
Das Modul befasst sich mit der Planungs- und Optimierungssituation landwirtschaftlicher Betriebe, wobei im Vorlesungsteil Theorie und Methodik im Vordergrund stehen und im Übungsteil ausgewählte Praxisbetriebe analysiert

und ausgehend davon für diese Zukunftsstrategien entwickelt werden.
Die Vorlesung vermittelt zunächst den theoretischen Horizont, um die individuelle Planungs- und Optimierungssituation landwirtschaftlicher Betriebe in den natürlichen, technologischen, ökonomischen und politischen Kontext einzuordnen und bewerten zu können. Des Weiteren werden analytische Kennzahlen theoretisch erarbeitet und vergleichend diskutiert sowie auf reale Betriebsverhältnisse/Planungsprobleme angewandt.
Risikoquantifizierung und -management wird schließlich ebenso vermittelt wie auch produktionsökonomische Modellierungs- und Analysemethoden bis hin zur Anwendung relevanter statistischer Methoden und die Diskussion bedeutender Konzepte der Betriebsinnovation.
Im Übungsteil werden den Studierenden zunächst ausgewählte, für die Betriebsanalyse erforderliche Rechnungssysteme und betriebswirtschaftliche Unternehmenskennzahlen in Erinnerung gerufen. Es folgen die Betriebsbesuche (z.B. Marktfruchtbau, Milchviehhaltung, Schweinemast), bei denen die Studierenden sich ein Bild über die Ist-Situation der Betriebe machen und erforderliche Daten u.a. im Rahmen von Betriebsleitergesprächen erheben können. Daran schließt sich in Gruppenarbeit die betriebswirtschaftliche Analyse der Betriebszweige und die Erarbeitung betriebsspezifischer Entwicklungsstrategien unter Berücksichtigung sich wandelnder Märkte sowie agrar- und gesellschaftspolitischer Rahmenbedingungen an.

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme des Moduls sind die Studierenden in der Lage, die Planungs- und Optimierungssituation landwirtschaftlicher Betriebe im natürlichen, technologischen, ökonomischen und politischen Agrarsystemkontext zu beurteilen. Sie können Risiken quantifizieren, sie verstehen die wesentlichen Komponenten des Risikomanagements und können Massnahmen im Rahmen des Risikomanagements entwickeln. Ebenso sind sie in der Lage, produktionsökonomische Zusammenhänge im landwirtschaftlichen Betrieb unter zentraler Beachtung agrarsystemischer Zusammenhänge zu analysieren und zu modellieren.
Darüber hinaus sind die Studierenden dazu befähigt, für die Betriebsanalyse geeignete Rechnungssysteme und betriebswirtschaftliche Unternehmenskennzahlen anzuwenden.
Sie sind in der Lage, landwirtschaftliche Betriebszweige (z.B. Marktfruchtbau, Rinder- oder Schweinehaltung) zu analysieren und betriebliche Entscheidungen unter Berücksichtigung sich ändernder Rahmenbedingungen vorzubereiten. Insbesondere können sie existente landwirtschaftliche Betriebe mit ihrer Vielzahl an Betriebszweigen betriebswirtschaftlich bewerten und Strategien für die zukünftige Betriebsentwicklung erarbeiten.

Teaching and Learning Methods:
Durch die im Rahmen des Lehrformates Vorlesung vornehmlich gewählte Lehrmethode Vortrag können die theoretischen Grundlagen und Methoden am besten vermittelt werden. Im Rahmen der Übung wenden die Studierenden ihr erworbenes Wissen an: Ausgehend von den in der Regel drei Betriebsbesuchen erstellen die Studierenden in Gruppenarbeit (vorzugsweise 3-4 Studierende) betriebswirtschaftliche Analysen und entwickeln entsprechende Unternehmensstrategien. Die von jeder Gruppe gehaltene Präsentation und angefertigte zweiseitige Zusammenfassung in Textform dient der Ergebnisdarstellung. In den Diskussionen lernen die Studierenden, unterschiedliche Sichtweisen zu integrieren und die erarbeiteten Ergebnisse richtig einzuordnen und kritisch zu beurteilen.

Media:
PowerPoint-Präsentationen, Skriptum, Tafelarbeit, Datensätzen, Software - Anwendungen

Reading List:
Coelli, T.J., Prasada Rao D.S., O`Donnel, C.J., Battese, G.F.: An Introduction to Efficiency and Productivity Analysis. 2nd ed., Heidelberg, Berlin 2005. Mußhoff, O., Hirschauer, N.: Modernes Agrarmanagement. 3. Aufl., München 2013 Dabbert, S., Braun, J.: Landwirtschaftliche Betriebslehre. 3. Aufl., Stuttgart 2012. Schindler, M.: Die Landwirtschaft. Wirtschaftslehre. 13. Aufl., München 2010. KTBL: Betriebsplanung Landwirtschaft 2020/21. Daten für die Betriebsplanung in der Landwirtschaft, 27. Aufl., Darmstadt 2020. Kuhlmann, F.: Betriebslehre der Agrar- und Ernährungswirtschaft. 3. Aufl., Frankfurt/Main 2007. DLG: Die neue Betriebszweigabrechnung. Frankfurt/Main 2011.

Responsible for Module:
Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1545: Human Resource Management in Agriculture and Related Industries | Human Resource Management in Agriculture and Related Industries

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
During the written exam (90 min.) students demonstrate their ability to understand human resource management practices, to select and adapt techniques suitable to specific contexts in agriculture and life science industries, to compare and contrast techniques and practices, to evaluate and change selected practices in case applications. Example practices cover the fields of planning the workforce, recruiting, selecting, and training employees, as well as providing feedback to, and evaluating employees, as well as discipline and dismissal, compensation, incentive plans, benefits and services, and workplace diversity. Students analyze exam questions and write up answers in their own words.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
BS Degree. Prior knowledge of basic ideas of economics and management is required; knowledge in strategic management is recommended.

Content:
The course is designed to provide master level students with an understanding of pertinent human resource management practices and how to adapt practices from other industries to farms, horticultural and landscaping operations, in agribusinesses, in the food industry, and in related businesses. Practices relate to planning the workforce, recruiting, selecting, and training employees, as well as providing feedback to, and evaluating employees. Additional practices relate to discipline and dismissal, compensation, incentive plans, benefits and services, and workplace diversity. Examples of current issues as well as laws and regulations provide context for different human resource management practices.

Intended Learning Outcomes:
After successfully completing the module, students are able to accomplish the following:
- understand human resource management practices and their objectives;
- evaluate human resource management practices in use;
- develop and adapt appropriate human resource management practices for specific organizations in agriculture and the life science industries.
- determine the fit of different human resource management practices with different organizational goals and environments.

Teaching and Learning Methods:
Lectures serve to introduce human resource management practices and their objectives.
Video clips serve to illuminate HRM practices and as a basis of discussion of practices. Case descriptions and task sheets are analyzed in small groups and discussed in class to empower students to apply human resource management practices in specific constellations.

Media:
Presentation software, case descriptions and task sheets, discussion facilitation support media, video clips

Reading List:
Dessler, G. (latest edition). Human resource management, Prentice Hall: Upper Saddle River/NJ.

Responsible for Module:
Bitsch, Vera; Prof. Dr. Dr. h.c.

Courses (Type of course, Weekly hours per semester), Instructor:
Human Resource Management in Agriculture and Related Industries (WZ1545, englisch) (Seminar, 4 SWS)
Bitsch V [L], Bitsch V
For further information in this module, please click campus.tum.de or here.

Module Description

WI100311: Food & Agribusiness Marketing | Lebensmittelmarketing und Agribusiness-Marketing

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module grade is based on a research paper (10-15 pages, 50%) and a presentation (35-40 minutes, with 15-20 minutes per single student, 50%).
Groups of students work on questions related to the Argribusiness Marketing.
In the research paper students demonstrate their ability (1) to perform a market definition, (2) to outline an exemplary scientific market research study while using market research methods, and (3) execute examples for applying marketing instruments.
Students present and discuss partial results of the single parts (1-3) during the semester. The students integrate the feedback from the discussions into their research paper.
By presenting their results students show their ability to present scientific topics in a clear and comprehensible manner. By working in a team students demonstrate that they are able to solve the given task by constructively and conceptually collaborating in a team.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Marketing; Marketing Research

Content:
The module covers examples of agricultural marketing from agricultural management and marketing research. It discusses the following topics:

- market structure of agricultural and food economics;
- determination of objectives and strategies in agricultural marketing;
- management of brands, also store brands;
- communication in agribusiness marketing (advertising, cooperative advertising);

- price policy in agribusiness marketing;
- product- and quality-management in agribusiness marketing (effect on cooperation and integration);
- innovation und product differentiation;
- distribution, especially in food retailing.

Intended Learning Outcomes:
At the end of the module, students are able to develop marketing management and strategic considerations in marketing in the agribusiness sector. Students will be able to a) define essential characteristics of agricultural products and b) argue their consequences for commercialization.
In addition, they can assess microeconomic models for describing and analyzing marketing strategies in agribusiness. Moreover, students are able to evaluate current research in the field of agribusiness marketing.
Furthermore, the students will be able to develop a conceptual design for a practical problem in agribusiness marketing. They are able to judge the success of a marketing strategy by using current marketing literature.
Students are able to solve a given task by constructively and conceptually collaborating in a team.

Teaching and Learning Methods:
The module is held in the form of a seminar, where students in groups develop a marketing concept for an example product. Students are guided to research the suitable scientific literature and data for their example. They present their results to the other workshop participants and receive feedback in the discussion that they then integrate into their report. A workshop is the best way for the students to illustrate a marketing concept by means of a case study.

Media:
Presentation, scientific papers, textbook chapters

Reading List:
Meffert, H., Burmann, C., Kirchgeorg, M. (2015). Marketing: Grundlagen marktorientierter Unternehmensführung Konzepte - Instrumente – Praxisbeispiele, 12. Auflage. Wiesbaden: Springer-Gabler.

Responsible for Module:
Roosen, Jutta; Prof. Dr. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Lebensmittelmarketing und Agribusiness-Marketing (WI100311, deutsch/englisch) (Limited places) (Seminar, 4 SWS)
Roosen J [L], Benninger N
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1567: Sustainability: Paradigms, Indicators, and Measurement Systems | Nachhaltigkeit: Paradigmen, Indikatoren und Messsysteme

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung besteht aus einem schriftlichen Bericht (ca. 15 Seiten) sowie dessen Präsentation und Diskussion. Die Studierenden weisen im Rahmens des Berichts ihre Fähigkeit nach, die Auswirkungen eines Nachhaltigkeitskonzepts auf einen Forschungsansatz und auf Forschungsergebnisse zu beurteilen, ein aktuelles Messsystem zu beurteilen, eine organisationsbezogene oder produktbezogene Nachhaltigkeitsbehauptung zu beurteilen sowie ihre wichtigsten Lernergebnisse zusammenzufassen. In der Präsentation zeigen die Studierenden, dass sie die Kernaspekte ihres Berichtes anschaulich und verständlich vor Fachpublikum darstellen und professionell diskutieren können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundverständnis von ökonomischen und Management Konzepten sowie sozialwissenschaftlicher Forschungsmethoden erforderlich

Content:
Die Entwicklung eines differenzierten Nachhaltigkeitsverständnisses setzt die kritische Auseinandersetzung mit Nachhaltigkeitskonzepten auf verschiedenen Ebenen voraus. Im Seminar werden die folgenden Ebenen anhand von moderierten Diskussionen von zur Verfügung gestellten und in studentischen Recherchen erarbeiteten Materialien systematisch bearbeitet.
- Paradigmen und Werturteile in Forschung über und Beurteilung von Nachhaltigkeit;
- ökonomische, umweltbezogene und soziale Aspekte von nachhaltiger Produktion, Vermarktung und Konsum;
- Verfahren der Nachhaltigkeitsbewertung (einzelbetrieblich, Wertschöpfungsketten);
- öffentliche und private Standards, Nachhaltigkeitskennzeichnungen und -kommunikation;

- Auswirkungen von Messverfahren (z.B. mit Schwerpunkt im ökologischen, wie Carbon Footprint, oder im sozialen Bereich., wie Fair Trade).
Diese Inhalte werden im Bezug gesetzt zu aktuellen und kontrovers diskutierten Themen der Nachhaltigkeit in Wissenschaft und Gesellschaft.

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme am Modul sind die Studierenden in der Lage,
- die Auswirkungen unterschiedlicher Paradigmen auf das Nachhaltigkeitsverständnis in publizierten wissenschaftlichen Artikeln zu erkennen und zu beurteilen;
- produkt-, unternehmens- und wertschöpfungskettenbezogene Nachhaltigkeitsmessungen zu beurteilen und Auswirkungen abzuschätzen;
- öffentliche Nachhaltigkeitsbehauptungen anhand verfügbarer Informationsquellen einzuschätzen;
- ein differenziertes Verständnis von Nachhaltigkeit in einer vernetzen, globalisierten Umwelt mit unterschiedlichen Wertsystemen und Prioritäten in wissenschaftlichen und praktischen Fragestellungen anzuwenden.

Teaching and Learning Methods:
Seminar: Moderierte Diskussion von wissenschaftlichen Artikeln und Handouts zur Vorbereitung der studentischen Recherchen, damit die Studierenden ein vertieftes Nachhaltigkeitsverständnis entwickeln und die kritische Auseinandersetzung mit den jeweiligen Rechercheinhalten geschärft wird; studentische Präsentationen mit Diskussion, damit die Studierenden die kritische Auseinandersetzung mit Nachhaltigkeitskonzepten einüben. Durch die Ausarbeitung des Abschlussberichtes (einschließlich der wichtigsten Lernergebnisse) werden die unterschiedlichen Anwendungsgebiete von Nachhaltigkeitskonzepten integriert.

Media:
Wissenschaftliche Artikel und angewandte Informationen; Präsentationen und Recherche; Flipcharts und
andere diskussionsunterstützende Medien

Reading List:
National Resource Council 2010, Toward Sustainable Agricultural Systems in the 21st Century, Washington/D.C.:
National Academies Press;
sowie aktuelle Artikel und Webseiten nach Absprache

Responsible for Module:
Vera Bitsch bitsch@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0043: Risk Theory and Modeling | Risk Theory and Modeling

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In a written examination (120 minutes, Klausur), students demonstrate their theoretical knowledge of risk and the intuition behind various concepts. In written answers regarding the measurement of risk and the decision-making under risk, they prove their understanding of these concepts in both theory and practice. The ability to apply mathematical tools is proven by the solution of specific calculus problems. Further, students discuss assumptions under which a proposed research approach is appropriate and whether there might be better ways to investigate a specific research problem.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students taking this course should be familiar with the basics of microeconomics as well as probability measurement. However, all necessary concepts will be introduced before application.

Content:
- Definitions and sources of risk
- Risk attitude and the utility function
- Random variables and statistical measures of risk evaluation
- Value-at-risk
- Portfolio optimization
- Production decisions under risk
- Price analysis
- Real options

Intended Learning Outcomes:
Upon completion of the module, students are able to

- understand the various sources of risk in a broad range of sectors and industries,
- understand how economic decisions are made in the presence of risk,
- apply mathematical tools to evaluate risk with respect to products, processes and structure related decisions
- and understand how decision-making under risk is analyzed in the scientific literature

Teaching and Learning Methods:
The module consists of 2 SWS lectures and 2 SWS exercises. During lectures, concepts and tools will be presented to the students in slide shows. An interactive lecture atmosphere is intended to ensure that students' questions are answered right away. Further, exercises accompany the lecture contents. These exercises are meant to illustrate lecture contents and provide students with hands-on experience with the presented concepts to make them more graspable.
Toward the end of the course, when students are acquainted with the most important concepts, selected publications (both seminal papers and most recent ones) in risk research are presented and discussed. This provides students with an insight into how the lecture contents are applied in the scientific literature.

Media:
Presentation slides, Microsoft Excel files, hand-outs

Reading List:
Chavas, J. P.: Risk Analysis in Theory and Practice". Elsevier, San Francisco 2004.
Quiggin, J., Chambers R. G: Uncertainty, Production, Choice, and Agency: The State-Contingent Approach. Cambridge 2000.

Responsible for Module:
Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Risk Theory and Modeling - Lecture (WZ0043, englisch) (Vorlesung, 2 SWS)
Sauer J [L], Frick F, Henao Henao J

Risk Theory and Modeling - Exercises (WZ0043, englisch) (Übung, 2 SWS)
Sauer J [L], Frick F, Henao Henao J
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001412: Sustainability Assessment of Agri-Food Supply Chains | Sustainability Assessment of Agri-Food Supply Chains

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination format consists of a report (60% of the final grade; based on a LCA exercise; approx. 8-10 pages) supplemented by an oral presentation (40% of the final grade; approx. 20 - 30 minutes), where students will present a scientific study selected from a curated list.
The oral and written examination will assess the students' competency to i) understand and communicate the factors and concepts that define, shape, and quantify the sustainability of agri-food supply chains and ii) identify the challenges and opportunities in the field of sustainability assessment of agri-food supply chains to provide decision support and foster sustainable development.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Focused on the global challenges of natural resource conservation, ecosystem preservation, climate mitigation, and sustainable food consumption, this seminar is tailored for master students specializing in Sustainable Resource Management, Agrosystem Science, Ecological Engineering (Life Sciences), and Consumer Sciences (Management). However, addressing these challenges necessitates collaboration among several disciplines, and hence this research seminar also extends to master students with other background. Prerequisite is i) a strong interest in gaining knowledge on the factors and concepts underpinning sustainability assessment within agri-food supply chains and ii) to contribute to this interdisciplinary discourse by presenting a scientific study to your fellow students, participate in the group discussion and concisely summarize the key findings in a written report.

Content:
In an increasingly globalized world where the demand for natural resources continues to rise, the sustainability of food and agricultural supply chains has emerged as a critical concern, playing a pivotal role in achieving numerous Sustainable Development Goals. By comprehending and assessing the hotspots and drivers that impact the sustainability of agri-food supply chains, collaborative efforts between the scientific community, industry, and policymakers can effectively address the sustainability of agri-food systems, thereby advancing the SDGs. As a future graduate of TUM, you have the opportunity to contribute to this endeavor by: i) gaining foundational knowledge of the factors and concepts within the realm of sustainability assessment of agri-food supply chains ii) developing the ability to communicate this knowledge to a multidisciplinary audience for providing sustainable decision support. Through case studies at global and national levels, this seminar will familiarize you with the knowledge and quantitative methods necessary to gain a holistic understanding of the challenges and opportunities in promoting sustainable agri-food supply chains.

Intended Learning Outcomes:
After successfully completing this module, students will be able to articulate the factors and concepts that define, shape, and quantify the sustainability of agri-food supply chains to a multidisciplinary audience. In particular, students will acquire the ability to explain how:
a) agri-food systems affect sustainability by identifying the hotspots, drivers and levers in the global supply chain.
b) to assess sustainability of agri-food supply chains with quantitative methods including top-down and bottom-up life-cycle assessment, regionalized impact assessment methods, scenario modelling, and remote sensing.
c) to utilize the knowledge from a) and b) to provide sustainable decision-support for industry, policy and society, illustrated by case studies at global and national scales.

Teaching and Learning Methods:
Following an introduction on the factors and methodologies that delineate, influence, and measure the sustainability of agri-food supply chains, students will engage with these concepts by:
- Presenting a scientific study selected from a curated list to your fellow colleagues to foster a deeper understanding of real-world applications and challenges within the realm of sustainability assessment of agri-food supply chains.
- Active participation in group discussions that encourage critical thinking and the exchange of diverse perspectives to provide a dynamic platform for exploring the multifaceted aspects of sustainability within agri-food supply chains.
- Crafting a concise yet comprehensive summary on the challenges and opportunities intrinsic to the field of sustainability assessment for agri-food supply chains, allowing you to distill key insights and reflect on the broader implications in view of the SDGs.

Media:
Lecture inputs (in hybrid form), exercises with a semi-automated LCA software (based on matlab and tableau), student presentations + discussion.

Reading List:

Alexander, P., Brown, C., Arneth, A., Finnigan, J., Moran, D., & Rounsevell, M. D. (2017). Losses, inefficiencies and waste in the global food system. Agricultural systems, 153, 190-200.
Cabernard, L., Pfister, S., Oberschelp, C., & Hellweg, S. (2022). Growing environmental footprint of plastics driven by coal combustion. Nature Sustainability, 5(2), 139-148.
Camilleri, A. R., Larrick, R. P., Hossain, S., & Patino-Echeverri, D. (2019). Consumers underestimate the emissions associated with food but are aided by labels. Nature Climate Change, 9(1), 53-58.
Chaudhary, A., Verones, F., De Baan, L., & Hellweg, S. (2015). Quantifying land use impacts on biodiversity: combining species–area models and vulnerability indicators. Environmental science & technology, 49(16), 9987-9995.
Cucurachi, S., Scherer, L., Guinée, J., & Tukker, A. (2019). Life cycle assessment of food systems. One Earth, 1(3), 292-297.
de Adelhart Toorop, R., Yates, J., Watkins, M., Bernard, J., & de Groot Ruiz, A. (2021). Methodologies for true cost accounting in the food sector. Nature Food, 2(9), 655-663.
Hellweg, S., & Milà i Canals, L. (2014). Emerging approaches, challenges and opportunities in life cycle assessment. Science, 344(6188), 1109-1113.

Responsible for Module:

Cabernard, Livia; Prof. Dr.sc. ETH Zürich

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Agricultural Systems Technology and Digitalisation | Agrarsystemtechnik und Digitalisierung

Module Description

WZ1062: Agricultural Systems Engineering in Plant Production | Agrarsystemtechnik im Pflanzenbau

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer mündlichen Prüfung (30 Min.) erbracht. Dabei soll nachgewiesen werden, dass die Studenten in der Lage sind funktionale Zusammenhänge von Agrartechnologiesystemen im Pflanzenbau einzuschätzen. Darüber hinaus sollen sie anhand konkreter Anwendungsbeispiele aus dem Pflanzenbau nachweisen, dass sie neue verbesserte Agrartechnologiesysteme entwickeln können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen Landtechnik/Agrarsystemtechnik

Content:
Das Seminar soll einen Ausblick auf zukünftige technologische Entwicklungsstränge in der agrarischen Pflanzenproduktion aufzeigen.
- Zukünftige Einsatzmöglichkeit der Robotik in der Agrartechnik im Pflanzenbau in den beiden Bereichen Energie und Transport sowie als Prozesssystem. Der Bereich Energie- und Transportsystem reicht von der autonomen Steuerung aktueller Traktorsysteme bis zum Einsatz von Roboterschwärmen. Der Bereich der Prozessrobotik umfasst Tätigkeiten an der Nutzpflanze wie z.B. Aussaat, Bekämpfung von Beikulturen und Schädlingen und die Ernte.
- Die Sensorik im Bereich der Agrartechnik zur Erkennung von Boden- Pflanzen-, Klima- oder Bodenzuständen, wie auch die dafür benötigten Sensorträger und Sensortechnologien wie z.B. NIRS.

- Die Technologiesysteme: Saat, Bodenbearbeitung, Pflanzenschutz, Ernte und Logistik vor dem Hintergrund zukünftiger Technisierungsstufen.
- Das Datenmanagement und -analyse der aus den einzelnen Bereichen der Pflanzenproduktion gewonnen Daten sowie deren Austausch, Konvertierung, Bearbeitung, Auswertung und Anwendung mittels z.B. GNSS, ISO-BUS oder AgroXML.
- Zukünftige Mechanisierungssysteme vor dem Hintergrund ökologischer und gesellschaftlicher Anforderungen.
- Energiesysteme landwirtschaftliche Arbeitsmaschinen durch Nutzung regenerativer Energieträger wie z.B. Pflanzenöle, Biogas oder Wasserstoff über Brennstoffzellen sowie die Integration in die Elektromobilität.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage Technologiesysteme im Pflanzenbau zu analysieren, diese vor dem Hintergrund anderer Systeme zu bewerten und daraus zukünftige Systemansätze zu entwickeln. Sie können die Entwicklungsansätze von Smart Farming bewerten. Sie verfügen über strukturelle Grundlagen der Agrarrobotik und können weiterführende Nutzungsmöglichkeiten charakterisieren und entsprechende Verknüpfungen entwickeln.

Teaching and Learning Methods:
Auf Basis von Vorlesungen und Gruppenarbeiten werden bestehende Agrartechnologiesysteme analysiert. Dabei ist vorgesehen das in der Vorlesung an Beispielen die Analyse erläutert wird. In den anschließenden Gruppenarbeiten sollen die Kenntnisse an anderen Agrartechnologiesysteme eingeübt und hinterfragt werden. Die Gruppengröße passt sich der Gesamtgröße der Veranstaltung an so dass der einzelne Student entsprechende Methodenkenntnisse gewinnen kann. Über Übungen und Seminararbeiten werden diese Bewertet und neue Systeme entwickelt. In den Übungen werden die Ergebnisse der Gruppenarbeiten wieder ausgetauscht, diskutiert und weiterentwickelt. Je nach Lernstruktur der Gruppe kann die Weiterentwicklung auch in Seminararbeiten erfolgen um dem Einzelstudent entsprechende Umsetzungsmöglichkeiten zu bieten. Die Verteilung von Vorlesung, Gruppenarbeit und Übung/Seminararbeit ergibt sich nach der Lernstruktur der Gruppe und kann zur Zielerreichung im Verlauf angepasst werden.

Media:
Präsentationen

Reading List:

Responsible for Module:
Bernhardt, Heinz; Prof. Dr. agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Agrarsystemtechnik im Pflanzenbau (Vorlesung, 4 SWS)
Bernhardt H, Grebner S, Sebald C

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1070: Precision Livestock Farming | Agrarsystemtechnik in der Tierhaltung

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer mündlichen Prüfung (30 Min.) erbracht. Dabei soll nachgewiesen werden, dass die Studenten in der Lage sind, funktionale Zusammenhänge von Tierhaltungssystemen einzuschätzen. Darüber hinaus sollen sie anhand konkreter Anwendungsbeispiele aus der Tierhaltung nachweisen, dass sie neue verbesserte Tierhaltungssysteme entwickeln können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen Landtechnik/Agrarsystemtechnik

Content:
Die systemorientierte Analyse der Nutztierhaltungssysteme umfasst folgende Themenbereiche:
- Robotik in der Nutztierhaltung mit der Adaption an Nutztier und Halter sowie Sicherheits- und Regelungssystemen in diesem Bereich
- Die Sensorik der anfallenden Daten des Nutztieres und seiner Umgebung. Dies umfasst die einzelnen Sensorkreise des Nutztieres wie Identifizierung, Ortung, Gesundheits- und Leistungszustand, Futter- und Wasseraufnahme und Ausscheidungen als auch die dafür benötigten Sensorträger und Sensortechnologien wie z.B. RFID, SAW oder NIRS.
- Das Datenmanagement und -analyse der aus den einzelnen Bereichen der Nutztierhaltung gewonnen Daten sowie deren Austausch, Konvertierung, Bearbeitung, Auswertung und Anwendung.
- Die Struktur von Energiemanagementsysteme in der Nutztierhaltung und deren Auswirkungen auf regenerative Energiesysteme und den regionalen Energiemarkt im Zusammenhang mit der Nutztierhaltung.

- Immission und Emission von Tierhaltungsanalgen und deren Entstehungsgrundlage. Die technologischen Möglichkeiten deren Reduktion durch z.B. Stallsysteme, Lüftungsanlagen und Abluftbehandlung sollen auch vor dem Hintergrund des Klimawandels behandelt werden.
- Stallbausysteme für verschiedene Nutztiere wie z.B. Rinder, Schweine, Geflügel, Schaf und Ziege werden zukunftsorientiert analysiert und auch Haltungssysteme für neue Nutztiere wie z.B. Insekten entwickelt
- Die Tier-Technik-Mensch Interaktion wird im Hinblick auf ihre technologischen, sozialen und kulturellen Aspekte betrachtet.
- Entwicklungsmethoden für Haltungssysteme zur Umsetzung ethologischer Bedürfnisse der Nutztiere vor dem Hintergrund sozialer, technologischer und ökonomischer Aspekte

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage Systeme in der agrarischen Nutztierhaltung (für z.B. Rinder, Schweine, Geflügel,…) zu analysieren, diese vor dem Hintergrund anderer Systeme zu bewerten und daraus zukünftige Systemansätze zu entwickeln. Sie können technische Systeme in der Nutztierhaltung analysieren und bewerten. Sie können gesellschaftliche Anforderungen an die Nutztierhaltung strukturieren, charakterisieren und überprüfen. Die Studenten sind danach in der Lage auf Basis multipler Anforderung an die Nutztierhaltung neue Haltungssysteme zu entwickeln.

Teaching and Learning Methods:
Auf Basis von Vorlesungen und Gruppenarbeiten werden bestehende Tierhaltungssysteme analysiert. Dabei ist vorgesehen das in der Vorlesung an Beispielen die Analyse erläutert wird. In den anschließenden Gruppenarbeiten sollen die Kenntnisse an anderen Tierhaltungssystemen eingeübt und hinterfragt werden. Die Gruppengröße passt sich der Gesamtgröße der Veranstaltung an, dass der einzelne Student entsprechende Methodenkenntnisse gewinnen kann. Über Übungen und Seminararbeiten werden diese bewertet und neue Systeme entwickelt. In den Übungen werden die Ergebnisse der Gruppenarbeiten wieder ausgetauscht, diskutiert und weiter entwickelt. Je nach Lernstruktur der Gruppe kann die Weiterentwicklung auch in Seminararbeiten erfolgen um dem Einzelstudent entsprechende Umsetzungsmöglichkeiten zu bieten. Die Verteilung von Vorlesung, Gruppenarbeit und Übung/Seminararbeit ergibt sich nach der Lernstruktur der Gruppe und kann zur Zielerreichung im Verlauf angepasst werden.

Media:
Präsentationen

Reading List:

Responsible for Module:
Bernhardt, Heinz; Prof. Dr. agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Agrarsystemtechnik in der Tierhaltung [WZ1070] (Vorlesung, 4 SWS)

Bernhardt H [L], Bernhardt H, Grebner S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0228: Exercises in Precision Agriculture and Plant Phenotyping | Exercises in Precision Agriculture and Plant Phenotyping

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination uses the format of a Report (project report), in which students should demonstrate that they are able to apply the gained skills to address certain questions in research or applications, in the context of (but not limited to) precision agriculture and plant phenotyping. The report is supplemented by a presentation. The final grades are calculated from the following elements:
- On the topic of choice, each group of students (e.g., 3-4 persons but can also be solo) writes a project report (8-10 pages of A4 single line format, excluding references) (75% of the total grade), and
- Each group presents project results in 15 min following 5 min discussion (25% of the total grade).
The individual contribution to the group performance must be clearly visible (i.e., Author Contributions).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
- Knowing the basics of scientific programming (e.g., R, Matlab) is recommended.
- Knowledge gained in the course module "Precision Agriculture" is recommended, but not mandatory.

Content:
The module aims to transfer the practical methods and skills of using novel technologies for precision agriculture and plant phenotyping. The main topics include:

1. cameras, sensors, and integrated systems used in precision agriculture and plant phenotyping;
2. basics of using Matlab, R, and other related software packages;

3. drone (UAV) operation, image data acquisition and analysis pipeline;
4. spectrometer operation, plant and soil spectral measurements, and spectral data analysis;
5. digital image analysis methods and software packages;
6. GIS tools for spatial data analysis and visualization;
7. satellite imagery data acquisition, processing, and analysis;
8. detection of plant biotic and abiotic stresses using different sensors;
9. measuring field spatiotemporal variability and crop yield;
10. data science methods in precision agriculture and plant phenotyping;

Intended Learning Outcomes:
Upon successful completion of the module, students are able to:
- understand the basics of characterizing plant traits and crop field variability using non-destructive methods;
- apply basic sensors and software packages (e.g. R, Matlab) in practices;
- evaluate the potentials and limitations of different sensors and data science methods (e.g. for image segmentation and classification);
- design sensing and data analysis pipelines for solving practical problems;
- develop critical and systematical thinking skills;
- to present their results in a clear and comprehensible manner to an audience

Teaching and Learning Methods:
- The module delivers the practical skills of precision agriculture and plant phenotyping through demonstrations of operational and analytic methods, hands-on practices, and computer exercises.
- Students actively participate in the exercises and discussion, and write learning journals to reflect the critical aspects in the exercises, e.g., application potentials and limitations of methods.
- Students conduct exercises through teamwork, write reports on topics of choice, and present the results and discuss with classmates.

Media:
Zoom, Scripts, PowerPoint

Reading List:
- Current literature related to the topics
- Hu Y, Schmidhalter U (2023) Opportunity and challenges of phenotyping plant salt tolerance. Trends in Plant Science 28(5): 552-566. DOI: doi.org/10.1016/j.tplants.2022.12.010
- Hund A., Kronenberg L., Anderegg J., Yu K. & Walter A. (2019). Non-invasive field phenotyping of cereal development. In Frank Ordon & Wolfgang Friedt (Eds.), Advances in breeding techniques for cereal crops (pp. 249–292). Burleigh Dodds Science Publishing. https://doi.org/10.19103/AS.2019.0051.13
- Zhang J., Hu Y., Li F., Fue K.G. & Yu K. (2024). Meta-Analysis Assessing Potential of Drone Remote Sensing in Estimating Plant Traits Related to Nitrogen Use Efficiency. Remote Sensing, 16(5), Article 5. https://doi.org/10.3390/rs16050838

Responsible for Module:
Yu, Kang; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0029: Geographic Information Systems and Modelling | Geoinformationssysteme und Modellierung

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module is completed with an examination in the form of a written exam (90 minutes). The written exam is intended to test the students' ability to explain basic terms and methods from Geoinformatics in a concise and precise manner. In addition, it is to be tested whether the students are able to develop solution concepts based on the learned methods for modeling, analysis and visualization of geodata by means of simple spatial problems from the field of agricultural sciences. The answers partly require own formulations and drawings, partly answering multiple choice questions. Aids are not allowed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics of information science are recommended

Content:
The module covers the following application-neutral basic concepts and methods of geoinformatics:
- basic terms
- Geodetic reference systems
- geodata sources
- data modeling and GIS data models
- geodatabases
- GIS analyses
- Web GIS technology
- mobile GIS and GNSS
- introduction to practical work with GIS software

- exercises with GIS software on the topics of modeling, georeferencing, digitization, object-based analyses, integration of Geo Web Services

In addition, the module deals with the development of concepts for subject-specific problems in agricultural sciences (e.g. yield mapping, site-specific fertilization, erosion modeling) based on the subject-neutral methods. These will be developed by means of exercise examples with GIS software.

Intended Learning Outcomes:
After completing the module, students are able to understand the basic terms, concepts and methods of Geoinformatics for modeling, analysis and visualization of spatial information. Students are able to independently apply selected domain-neutral methods (data modeling, georeferencing, digitization, data analysis) using GIS software and to develop concepts for solving simple domain-specific problems in agricultural sciences based on these methods.

Teaching and Learning Methods:
The module consists of a lecture and two related courses with exercises. Selected basic concepts and fundamental methods of Geoinformatics are taught in the lecture and through presentations. In the exercises a two-stage concept is followed: In a first stage, the basic, subject-neutral methods taught in the lecture are practiced using functions of GIS software on the basis of exercise examples. In a second stage, the skills for the application of the methods are deepened on the basis of subject-specific spatial issues from the agricultural sciences (e.g. yield mapping, site-specific fertilization, erosion modeling) to such an extent that the students can independently develop solution concepts for simple domain-specific problems.

Media:
Presentations, blackboard, exercise sheets, GIS software

Reading List:
To be announced by the lecturer

Responsible for Module:
Thomas H. Kolbe thomas.kolbe@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Geoinformationssysteme 1 (Vorlesung, 1 SWS)
Donaubauer A

Übungen zu Geoinformationssysteme 1 (Übung, 1 SWS)
Donaubauer A

GIS-Anwendungen im Pflanzenbau (Übung, ,5 SWS)
Hülsbergen K [L], Hülsbergen K, Mittermayer M

GIS-Anwendungen in der Pflanzenernährung (Übung, ,5 SWS)

Hülsbergen K [L], Mittermayer M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1060: Precision Agriculture | Precision Agriculture

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module uses a written exam (120 min) for assessment, which mainly based on the criteria below:
- demonstrated understanding of the basic concepts of precision agriculture, and the fundamentals of the key technologies;
- know how to assess the effects precision farming technologies from a systems perspective;
- ability to analyze and interpret the biological meanings of sensor data for decision making;
- ability to apply techniques to certain problems of crop management; and
- critical thinking skills, for instance, the ability of comparing and evaluating different sensing and modeling methods, and assessing the limitations of each method in solving certain problems;

Repeat Examination:
Next semester

(Recommended) Prerequisites:
- Basic knowledge of agricultural engineering
- Basic knowledge of plant and soil sciences

Content:
The module introduces the concept, principles of precision farming technologies, and their applications and economics. Main topics include:
1. concept and technological advances of precision agriculture;
2. key supporting technologies including remote sensing, geographic information system (GIS), global positions system (GPS), navigation, robotics, automation and communication technologies, sensors and sensor-carrying platforms, and variable rate technology (VRT);
3. soil spatial variability (e.g. nutrient, water) measurement and management;
4. crop spatial variability (e.g. health, stress) and site-specific crop management;

5. yield monitoring and grain quality analysis;
6. plant phenotyping technologies and applications;
7. big data analysis in precision agriculture and plant phenotyping;
8. environmental and ecological implications of precision agriculture;
9. economics and adoption of precision farming technologies; and
10. challenges and future directions of precision agriculture.

Intended Learning Outcomes:
Upon successful completion of this module, students will be able to,
- understand the concept, technologies and principles of precision agriculture;
- apply sensing and modeling methods to analyze soil and crop spatial variability;
- analyze the problems of crop growth and health using sensing and modeling methods;
- evaluate the robustness and transferability of sensing and modelling methods;
- develop critical thinking ability for applying precision agriculture technologies for decision making;
- create strategies based on multidisciplinary knowledge and techniques to solve practical problems in precision agriculture.

Teaching and Learning Methods:
- The module will be instructed through lectures, and lectures with integrated (computer) exercises in order to enable students master the theoretical basis and practical skills of precision agriculture.
- The lecture serves as a systematical introduction of the knowledge and theoretical basis of precision agriculture. Case studies are used to deepen the understanding of knowledge and stimulate interactions.
- The exercises teach the practical applications through field visits, independent measuring and interpreting soil and crop variability using various sensors and modeling methods. The exercises also include computer exercises of analyzing and interpreting results based on several pre-collected example datasets.
- Students apply the knowledge and practical methods for exercises, conduct exercises through team work and discuss the results with the instructor and classmates.

Media:
PowerPoint, Scripts, computer exercise portfolio, TUM-Moodle, Zoom

Reading List:
Shannon, D.K., D. E. Clay, and N. R. Kitchen. 2018. Precision Agriculture Basics. ASA, CSSA and SSSA, Madison, WI, USA.
Bechar, A., 2021. Innovation in Agricultural Robotics for Precision Agriculture: A Roadmap for Integrating Robots in Precision Agriculture, 1st ed, Progress in Precision Agriculture. Springer, Cham.

Responsible for Module:
Yu, Kang; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

LS10047: Standardized In-vehicle Communication Networks in Off-road Vehicles | Standardized In-vehicle Communication Networks in Off-road Vehicles

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
During a written examination (Klausur, 90 min., essays, definitions, numeric problems, creating programs on paper, No paper or electronic material is allowed in the written exam session, only a scientific calculator without programming capabilities; graphing calculators are strictly prohibited.) students have to show their ability to explain terms, communication principles, key parameters and properties of vehicle communication systems. They have to present bus arbitration details.
In addition, a given list of data frames has to be analyzed and converted into signals.
Students have to show their ability to create data frames from given signals by using attached standard pages.
Furthermore, they have to create ISO-XML data structure on given template on examination paper, as well as to explain oscilloscope screenshot events and to illustrate address claiming principles.
Explain software middleware principals and concepts.

In addition, there is the possibility of providing a voluntary mid-term performance as course work in accordance with APSO §6, 5.
Therefore, students demonstrate in a written report of no more than 4 pages of DIN A4 that they are able to present and critically evaluate the handling of data previously learned in the exercises by using their own experimental data and its analysis.
0,3 can improve the module grade by passing the course work, if the overall impression better characterizes the student's performance level and the deviation has no influence on passing the examination.
For the mid-term performance, no repetition date is offered. In the event of a repetition of the module examination at the next possible date, a successfully passed mid-term performance will be considered.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Recommended prerequired knowledge involves basic mathematics, basic software development skills and basics of electric circuits. It is recommended to study the module WZ1295 Positioning and Navigation for Off-Road Vehicles before this module, to gain required basic Matlab programming skills.

Content:
In the module, a full stack of communication technology is studied. The content is:
- topology and physical layer of tractor-implement communication, OSI model
- basics of CAN bus, including protocol, addressing, bus arbitration and bit stuffing
- history of multi-brand tractor-trailer interoperability, original design requirements
- addressing in vehicle networks, function and manufacturer codes
- tractor ECU functionality, for tractor-implement automation
- task controller ISOBUS functionality, for precision farming
- diagnostics methods in vehicle networks
- middlewares for future system design in modular vehicles

Intended Learning Outcomes:
After completion of the module, the students are familiar with the core technologies related to vehicle communication. They gain deep understanding of wiring and topology principles.
Students are able:
• to describe principles of communication networks, like physical layer and topology
• to describe the communication layers of vehicle communication networks
• to describe bus arbitration principles of network access
• to debug the network communication at protocol level
• to create small software programs that interconnect in the same vehicle network
• to design communication requirements for application in modular vehicle systems.
• to describe a middleware communication channel, and the benefits of using such in a future system.

Teaching and Learning Methods:
The module contains lectures in which the theoretical principles are learned. After each lecture, an exercise session follows and students are able to learn the topic more hands-on, either by using electronics tools, analyzers, or software development environment. The module may contain excursions and pairwise projects; to be announced in the first lecture.

Media:
To be announced in the first lecture.

Reading List:

Oksanen, T. and Auernhammer, H., 2021. ISOBUS: The Open Hard-wired Network Standard for Tractor-implement Communication, 1987-2020. doi:10.13031/913C0121

Brodie, S., Oksanen, T. and Auernhammer, H., 2023. Buzzword ISOBUS. Informatik Spektrum, 46(1), pp.46-50.

Siponen, M., Seilonen, I., Brodie, S. and Oksanen, T., 2022. Next generation task controller for agricultural machinery using OPC unified architecture. Computers and Electronics in Agriculture, 203, p.107475.

Lecture notes. To be announced in the first lecture.

Responsible for Module:

Oksanen, Timo, Prof. Dr. timo.oksanen@tum.de Brodie, Samuel, M.Eng. samuel.brodie@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

Standardized In-vehicle Communication Networks in Off-road Vehicles (Lecture) (Vorlesung, 2 SWS)
Oksanen T

Standardized In-vehicle Communication Networks in Off-road Vehicles (Exercise) (Übung, 3 SWS)
Oksanen T [L], Brodie S, Oksanen T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0261: Simulation of Cropping Systems | Simulation of Cropping Systems

Simulation

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 82.5	**Contact Hours:** 67.5

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination performance will be in the form of a project work presentation. The project report will describe a systems problem in cropping, its translation into a scientific question and the application of a crop model in R to answer this question. The project report will be about 12 pages and must be presented at the end of the semester in a final presentation. The report, presentation and discussion should show that participants have an ability to sufficiently understand the context of cropping systems, the interactions between different plant resources such as light and water and have developed a critical view of model abstraction versus real systems. They need to show an ability to understand the potential of models to gain new inside in to cropping systems as well as the limitations of crop models to simulate such system. The report and the presentation are the final type of assessment. By passing additional brief quizzes that are offered during the semester each students gets the chance to get an 0.3 grade bonus if the final assessment is passed and 75% of the quizzes are passed, too. A repetition of the midterm assessments is not possible. If a repetition exam is taken in the following semester and the grade bonus was achieved, it will be transferred.
The possibility of repetition of the exam is given at the end of the semester.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge in biology, crop physiology, physics, chemistry, hydrology, mathematics, statistics and programming language R, based on the bachelor's degree in Agricultural and Horticultural Sciences

Content:
The module includes aspects of the yield physiology of crops: C-balance (photosynthesis, respiration, C-allocation), water balance, light uptake, growth and development and model representations of these components in a cropping system with numerical solutions, crop models and coding in R.

The course will contain two components. First, students will be exposed to basic concepts of systems analysis, modeling and computer simulation of agricultural and biological systems. Emphasis will be placed on continuous simulation of dynamic models with examples that give students a broad exposure to dynamic simulation models. An overview of applications of models in agricultural and biological systems will be given. Basics of working with R and a simple crop model developed in R will be taught via e-learning tools and seminars during this first half of the semester.

The second part of the course will introduce students to a simple dynamic crop simulation model. They will apply their knowledge of R and the simple crop model in R, to modify the model and apply it for a class projects. Lectures will expose the students to various methods for working with dynamic models, including parameter estimation, model evaluation, and sensitivity analysis which they will apply in a project work. Students will also be exposed to uncertainties in models associated with uncertainties in model parameters, inputs, and structure.

Intended Learning Outcomes:
After successfully completing the module, students are able to:
- Understand general concepts of cropping systems and crop simulation models, including Systems Approach, Model development, Example models and Numerical Simulation,
- Create basic routines to simulate dynamic behavior using numerical solutions,
- Understand a simple crop simulation model in R, supplied from the literature, with the basic structures of a cropping system,
- Apply a simple crop model in R to a new problem using Parameter estimation, Model evaluation and Sensitivity analysis,
- Evaluate crop model performance in R with field experimental data,
- Understand the potential of models to gain new systems inside in cropping systems analysis,
- Understand the limitations of crop models to simulate a cropping system,
- Analyze model uncertainty.

Teaching and Learning Methods:
The basic modeling approaches of cropping systems processes are presented and supplemented in the lectures by example from different models and recent research. In the accompanying exercises, parallel to lecture material, student will individually read scientific literature and carry out exercises on methods of model development, parameterization, evaluation, sensitivity analysis and uncertainty analysis. In a seminar setting, the first part of the semester will be accompanied with e-learning developed for this module, they will learn the basics of R and how a simple model is applied in R (1SWS for first half of semester). Students will prepare homework exercises on model creation and discuss these and literature in class. The lectures will be accompanied with

regular brief quizzes to test their comprehension of new definitions and concepts. Students are encouraged to assist each other in homework (understanding reading material and in performing specific modeling tasks) and during discussion in class.

Media:
PowerPoint Presentations, leaflet of the lecture in pdf format, E-modules (brief videos), exercise portfolio and quizzes.

Reading List:
Handouts will include pages from:
Wallach, D., D. Makowski J. W. Jones and F. Brun. 2019. Working with Dynamic Crop Models. Methods, Tools and Examples for Agriculture and Environment. Third Edition. Academic Press, London.
Keen, R.E. and J.D. Spain. 1992. Computer simulation in Biology: A Basic Introduction. Wiley-Liss Inc. New York. (Selected Chapters - Book out of print.)
Jones, J.W. and Luyten, J.C. 1998. simulation of Biological Processes. In: Peart, R.M. and Curry, R.B. (eds). Agricultural Systems Modeling and Simulation. Marcel Dekker Inc. ISBN 0-827-0041-4.
Thornley, John H.M. and Ian R. Johnson.2000. Pland and Crop Modeling: A Mathematical Approach to Plant and Crop Physiology. Oxford University Press. New York. Blackburn Press (Second Printing.)

Additional Readings:
De Wit, C.T., 1992. Resource use efficiency in agriculture. Elsevier Applied Science, London.
Landau, S., Mitchell, R.A.C., Barnett, V., Colls, J.J., Craigon, J., Moore, K.L., Payne, R.W., 1998. Testing winter wheat simulation models' predictions against observed UK grain yields. Agricultural and Forest Meteorology 89, 85-99.
Lobell, D.B., Cassman, K.G., Field, C.B., 2009. Crop Yield Gaps: Their Importance, Magnitudes, and Causes. Annual Review of Environment and Resources 34, 179-204.
Lobell, D.B., Field, C.B., 2007. Global scale climate - crop yield relationships and the impacts of recent warming. Environmental Research Letters 2.
Sinclair, T.R., Muchow, R.C., 1999. Radiation use efficiency. Advances in Agronomy 65, 215-265.
Asseng S, et al. (2015) Rising temperatures reduce global wheat production. Nature Climate Change 5:143-147.
Asseng S, et al. (2013) Uncertainty in simulating wheat yields under climate change. Nature Climate Change 3:827-832.
Chenu K, Porter JR, Martre P, Basso B, Chapman SC, Ewert F, Bindi M, Asseng S (2017) Contribution of crop models to adaptation in wheat. Trends in Plant Science 22:472-490.
Lobell DB, Asseng S (2017) Comparing estimates of climate change impacts from process-based and statistical crop models. Environmental Research Letters 12.
Zhao C, Liu B, Xiao LJ, Hoogenboom G, Boote KJ, Kassie BT, Pavan W, Shelia V, Kim KS, Hernandez-Ochoa IM, Wallach D, Porter CH, Stockle CO, Zhu Y, Asseng S (2019) A SIMPLE crop model. European Journal of Agronomy 104:97-106.
Zotarelli et al. 2010 Step by Step Calculation of the Penman-Monteith Evapotranspiration (FAO-56 Method), IFAS Publication, University of Florida

Responsible for Module:
Asseng, Senthold; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Simulation Cropping Systems (Vorlesung mit integrierten Übungen, 4 SWS)
Asseng S [L], Asseng S, Bassu S

R for crop modelling (Übung, 2 SWS)
Asseng S [L], Bassu S
For further information in this module, please click campus.tum.de or here.

Overarching Electives | Übergreifende Wahlmodule

Module Description

SOT62303: History and Remembrance | Geschichte und Erinnerung

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 36	**Contact Hours:** 24

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module is completed with a presentation (10-15 minutes, for group presentations 10 minutes longer for each additional participant) in which the students demonstrate that they can classify historical events politically, assess their individual, social and political consequences and discuss how to deal with them collectively.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The seminar provides insights into different aspects of the connection between history and the present:
- Historical-political: source-based thematic introduction to political, economic and social contexts of historical events (e.g. totalitarianism of National Socialism).
- Historical-biographical: classification of life stories and statements by contemporary witnesses (e.g. of prisoners and their fate).
- Present: discussion of the collective confrontation with historical events (e.g. culture of remembrance - in the Federal Republic of Germany with its own history of persecution and totalitarianism).
Thematic focuses are totalitarianism and human rights, persecution and extermination, marginalization and discrimination, tolerance and civil courage.

Intended Learning Outcomes:
Students are able to identify the political-social contexts of specific historical events, classify individual biographies and statements by contemporary witnesses in relation to the events and their contexts and critically discuss aspects of the culture of remembrance and collective coming to terms with the past.

Teaching and Learning Methods:
Lecture, guided tour, film analysis, presentations, discussions, group work, self-study, especially reading, processing of source material

Media:
Lecture, reader, exhibitions, historical sources incl. film and photo material

Reading List:
Bundeszentrale für politische Bildung: Dossier: Geschichte und Erinnerung, online: https://www.bpb.de/themen/erinnerung/geschichte-und-erinnerung/

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Discrimination, Persecution and Extinction: Dachau Concentration Camp in History & Present (Seminar, 1,5 SWS)
Raith F, Wernecke J
For further information in this module, please click campus.tum.de or here.

Module Description

SOT62403: Project Week: Creative Mind Change. A Creativity Workshop | Projektwoche: Creative Mind Change. Eine Kreativitätswerkstatt

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** irregularly
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 15	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Das Modul wird mit einer Prüfungsleistung in Form eines lehrveranstaltungszentrierten Lerntagesbuches (1000 – 1200 Wörter) abgeschlossen. Im Lerntagebuch zeigen die Studierenden durch die reflexive Beschreibung ihrer persönlichen Aneignung der Lehrinhalte des Workshops, dass sie in der Lage sind, künstlerische Methoden einzusetzen, um bisher latente Zusammenhänge und Lösungswege zu erkennen. Insbesondere gehen sie darauf ein, welche kreativen Methoden ihr persönlichen Denkmuster (mind set) in welcher Weise erweitert haben.

Repeat Examination:

(Recommended) Prerequisites:
Keine Voraussetzungen.

Content:
Der Workshop eröffnet Erfahrungsräume
- die Grenzen des eigenen Denkens und Handelns zu überwinden
- Potentiale des eigenen Bewusstseins zu entdecken
- Kreativität als Potenzierung von sinnhaften Verknüpfungen zu schaffen.
- Potential für Coping-Strategien hinsichtlich innovativer Erkenntnisse, Verfahren sowie Produkte etc. zu entdecken.

Intended Learning Outcomes:
Nach der Teilnahme sind die Studierenden in der Lage …
- die eigenen kreativen Potentiale zu erkennen,
- die Abhängigkeiten von bisherigen Erfahrungs- und Denkmustern zu verstehen

- die erworbenen künstlerischen bzw. kreativen Methoden anzuwenden, um komplexe Phänomene abzubilden und hieraus konkrete Handlungsoptionen zu entwickeln.
- Coping Strategien hinsichtlich (scheinbar) divergenter Themen, Begriffe, Vorstellungen, Handlungsmodelle und Produkte zu entwickeln.

Teaching and Learning Methods:
Fünf ganztägige Workshops führen mit Experteninput und Diskussionen in Aspekte künstlerischen Arbeitens ein. In Kooperation mit der Kunstakademie Bad Reichenhall vermitteln drei Dozenierende den Teilnehmenden unterschiedliche kreative Praktiken (Werkstattcharakter vor Ort an der TUM), die praktisch erprobt (künstlerische Medien), theoretisch in Diskussion und Vortrag vermittelt und in Form von Gruppenarbeit und Präsentation vertieft werden.
Inhalt und Ziel des Projekts: Anwendung der erworbenen Kenntnisse auf KI-Modelle wie etwa DALL-2, um Möglichkeiten und Grenzen neuer Kreativitätspotentiale in der Kommunikation von Technologie und genuin humaner Kreativität auszuloten. Die Prüfungsleistung wird in Form eines Lerntagebuches (unterstützt durch Literaturvorgaben) in Form einer verschriftlichen Reflexion abschließend dokumentiert.

Media:
Vortrag, Skripte, Reader, Gestaltungsmaterial (Farben etc.), Technikmedien (u.a. Foto, Video).

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Projektwoche: Creative Mind Change. Eine Kreativitätswerkstatt (Workshop, 3 SWS)
Wernecke J [L], Passola i Lizandra E
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0123: Arabic Communication A1 | Arabisch Kommunikation A1

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:** irregularly
Credits:* 1	**Total Hours:** 45	**Self-study Hours:** 30	**Contact Hours:** 15

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Studien-/Prüfungsleistungen:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse (hier: mündliche Kommunikationsfähigkeiten) überprüft. Format: Audiodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Gesicherte Kenntnisse der Stufe A1

Content:
In diesem Modul steht die mündliche Kommunikation in der Fremdsprache Arabisch im Vordergrund. Es werden Kenntnisse vermittelt, die es den Studierenden ermöglichen, im einfachen Kontext, d. h. in verschiedenen alltäglichen Situationen und zu Themen von allgemeinem Interesse zusammenhängend und verständlich zu kommunizieren. Dabei wird ein Spektrum an Vokabular, Redewendungen und Dialogmustern erarbeitet; interkulturelle und landeskundliche Aspekte berücksichtigt; Schwerpunkte der Grammatik gemäß der Niveaustufe wiederholt bzw. vertieft und gefestigt. Die aktive Mitarbeit der Studierenden wird erwartet und gefördert.

Intended Learning Outcomes:
Nach Abschluss des Moduls können die Studierenden entsprechend der Niveaustufe A1 sich an leichteren Gesprächen im Alltag beteiligen, einfach und zusammenhängend in alltäglichen Kommunikationssituationen verstehbar reagieren, sofern sie in klarer Standardsprache vorgetragen werden und die Thematik vertraut ist.

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; gezielte Sprechübungen; Einzel-Partner- und Gruppenarbeit; kontrolliertes Selbstlernen mit vorgegebenem Material.

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Arabisch A1 - Kommunikation (Seminar, 1 SWS)
Aboelgoud E
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0222: Cantonese A1.1 | Kantonesisch A1.1

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:** irregularly
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft.

Die Prüfungsaufgaben beinhalten Fragen zur Anwendung von Wortschatz und Grammatik, zu Lese- und Hörverstehen sowie Aufgaben zur freien Textproduktion in Schriftzeichen/Pinyin und wird entweder in Form von einer Präsenzprüfung oder Portfolioprüfungsaufgaben abgehalten.

Hilfsmittel sind erlaubt.

Mündliche Reaktionsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. In diesem Fall beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Die Teilnehmer sollten vor allem Interesse an der kantonesischen Sprache und Kultur mitbringen. Vorkenntnisse im Chinesischen oder im Umgang mit chinesischen Schriftzeichen sind von Vorteil, jedoch nicht zwingend erforderlich.

Content:
In dem Kurs wird zunächst eine kurze Einführung in die Geschichte und Kultur der kantonesischen Sprache geboten. Nachdem die Teilnehmenden dann ein erstes Verständnis für die Phonologie und Tonregeln des Kantonesischen entwickelt haben, werden thematisch geordnete Vokabeln und Grammatikstrukturen präsentiert.

Die Sitzungen selbst konzentrieren sich auf die gesprochene Sprache und das Führen von einfachen Gesprächen im Alltag.Die behandelten Themen sind sorgfältig ausgewählt und spiegeln Alltagssituationen wider. Zum Beispiel Begrüßungen, Selbstvorstellung, Zahlen, Zeitangaben, Einkaufen, Hobbys, Essenbestellungen in Restaurants und das Erfragen von Wegbeschreibungen. Darüber hinaus bietet der Kurs zahlreiche Übungen und Wiederholungen, um den Teilnehmenden zu helfen, die Vokabeln rasch zu erlernen und die Ausdrücke aktiv anzuwenden.

Intended Learning Outcomes:
Nach erfolgreich abgeschlossenem Modul sind die Teilnehmer und Teilnehmerinnen in der Lage, den grundlegenden Wortschatz und die Grammatik des modernen Kantonesisch zu vermitteln, und ihre Studien selbständig fortzusetzen. Durch eine Einführung in die kantonesischen Schriftzeichen und Ausspracheregeln erhalten die Studenten auch ein besseres Verständnis für die Entwicklung der chinesischen Sprachen.

Teaching and Learning Methods:
Einzelarbeit zum individuellen sowie Partner- und Gruppenarbeit zum kommunikativen und handlungsorientierten Erarbeiten der Inhalte; Referate können gehalten werden. Hausaufgaben zur Vor- und Nachbearbeitung sind freiwillig und fördern die Beherrschung der Zielsprache.

Media:
Lehrbuch, Übungsblätter, Online-Materialien, Zeitungsartikel, Kurzfilme

Reading List:
Vom Kursleiter selbst angefertigte Übungsmaterialien. Weitere Lehrmaterialien/Lehrbuch werden in der LV bekanntgegeben.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Blockkurs Kantonesisch A1.1 (Seminar, 2 SWS)
Cai J
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0224: Chinese B2.2 - Chinese in Business | Chinesisch B2.2 - Wirtschaftschinesisch

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:** irregularly
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft.

Die Prüfungsaufgaben beinhalten Fragen zur Anwendung von Wortschatz und Grammatik, zu Lese- und Hörverstehen sowie Aufgaben zur freien Textproduktion in Schriftzeichen/Pinyin und wird entweder in Form von einer Präsenzprüfung oder Portfolioprüfungsaufgaben abgehalten.

Hilfsmittel sind erlaubt.

Mündliche Reaktionsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. In diesem Fall beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Erfolgreiche Teilnahme an der Stufe B2.1, Wirtschaftschinesisch 1 oder vergleichbare Kenntnisse. Die Teilnehmer sollen Interesse an dem Thema und Fachbereich Wirtschaft mitbringen.

Content:
Der Kurs Wirtschaftschinesisch 2 hat den Schwierigkeitsgrad B2.2 nach dem Gemeinsamen Europäischen Referenzrahmen für Sprachen (GER).
In dieser LV werden Kenntnisse über schwierige Grammatikstrukturen, fachspezifische Begriffe und Themen vermittelt. Sprachkenntnisse in Mandarin-Chinesisch werden erarbeitet, die es den Studierenden ermöglichen, sich in der Arbeit, zu Themen wie das Marketing, das Käuferverhalten,

die Finanzverwaltung, die Finanzabrechnung, sowie unterschiedliche Firmenkulturen selbständig in der Zielsprache zu verständigen. Außerdem werden Möglichkeiten aufgezeigt, den Lernprozess in der Fremdsprache Chinesisch effektiver zu gestalten und damit die eigene Lernfähigkeit zu verbessern.

Intended Learning Outcomes:
Nach der Teilnahme an dieser Veranstaltung sind die Studierenden in der Lage, sicher an allgemeinen Gesprächen teilzunehmen, über spezielle Themen zu diskutieren und Präsentationen zu Themen wie Marketingstrategien und Unternehmenskulturen zu halten.
Die Studierenden sind außerdem in der Lage, mündlich und schriftlich einfach und zusammenhängend über Erfahrungen und Ereignisse zu berichten. Sie können etwa 250 chinesische Wörter des Wirtschaftsvokabulars für die Berufskommunikation verstehen und anwenden.
Darüber hinaus kennen sie etwa 10 bekannte chinesische Marken und Unternehmen und verfügen über grundlegende Kenntnisse im Umgang mit aktuellen chinesischen Apps.

Teaching and Learning Methods:
Einzelarbeit zum individuellen sowie Partner- und Gruppenarbeit zum kommunikativen und handlungsorientierten Erarbeiten der Inhalte; Referate können gehalten werden. Hausaufgaben zur Vor- und Nachbearbeitung sind freiwillig und fördern die Beherrschung der Zielsprache.

Media:
Lehrbuch, Übungsblätter, Online-Materialien, Zeitungsartikel, Kurzfilme

Reading List:
Vom Kursleiter selbst angefertigte Übungsmaterialien. Weitere Lehrmaterialien/Lehrbuch werden in der LV bekanntgegeben.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Chinesisch B2.2 - Wirtschaftschinesisch (Seminar, 2 SWS)
Shih-Skalden Y
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0225: Chinese - China Digital | Chinesisch - China Digital

Version of module description: Gültig ab winterterm 2024/25

Module Level:	Language:	Duration:	Frequency:
Credits:* 1	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

SZ0357: German as a Foreign Language B1.1 - Start at Companies | Deutsch als Fremdsprache B1.1 - Einstieg ins Unternehmen

Version of module description: Gültig ab winterterm 2023/24

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 4	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache B1.1 - Einstieg ins Unternehmen (Seminar, 3 SWS)
Karsten-Ott M
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0359: German as a Foreign Language B2.2 - Start at Companies | Deutsch als Fremdsprache B2.2 - Einstieg ins Unternehmen

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** irregularly
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Erlaubte Hilfsmittel werden jeweils definiert.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Gesicherte Kenntnisse der Stufe B2.1; Einstufungstest mit Ergebnis B2.2

Content:
Das Modul orientiert sich am Niveau B2.2 des GER. In diesem Modul werden Kenntnisse in Deutsch als Fremdsprache erarbeitet, die es Studierenden ermöglichen, im beruflichen Kontext aktiv und flüssig zu kommunizieren.
Anhand verschiedener Themenfelder des Berufseinstiegs wie z.B. Stellensuche, Bewerbung und der erste Arbeitstag werden Situationen aus dem Arbeitsleben simuliert. Dazu gehört über die eigene Branche und Berufsziele sprechen, einen Lebenslauf schreiben, Telefonate führen, sich im Vorstellungsgespräch präsentieren, Small Talk, Einstand und Kennenlernen der Kolleginnen und Kollegen.

Die Studierenden erarbeiten ein Spektrum an Vokabular für den Berufseinstieg, Redewendungen und Dialogmuster und benutzen Diskursmuster eines Vorstellungsgesprächs wie z.B. Selbstpräsentation, über Stärken und Schwächen sprechen, über Karriereziele sprechen.
Sie analysieren den Satzbau in komplexen Sätzen, setzen sich mit den entsprechenden Konnektoren auseinander und vertiefen Grammatikthemen wie z.B. den Gebrauch des Konjunktiv II für den höflichen Umgang im Gespräch oder Nominalisierungsstrategien für den Lebenslauf.
Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Im Anschluss an die Teilnahme an die Modulveranstaltungen können die Studierenden auf B2.2-Niveau auf formelle und informelle Kommunikationssituationen beim Berufseinstieg mündlich spontan und zusammenhängend und schriftlich angemessen und gut verstehbar reagieren.
Sie sind in der Lage, anhand realitätsnaher Szenarien eine Bewerbung zu schreiben, ein Telefonat mit einer Firma zu führen und situationsgerecht zu interagieren. Die Studierenden können sich im Vorstellungsgespräch in einer Firma ausführlich und strukturiert präsentieren und auf Nachfragen angemessen reagieren. Sie unterscheiden formelle und informelle Redewendungen in E-Mails und können je nach Situation ihren Stil anpassen.
Sie können bezogen auf das eigene Fach flüssig sprechen und auf die Fragen anderer eingehen, sofern sie in der Standardsprache vorgetragen werden. In Konfliktsituationen können sie mit geeigneten Redemittel mitdiskutieren.

Teaching and Learning Methods:
Das Modul besteht aus einer Lehrveranstaltung, in der die angestrebten Lerninhalte mit gezielten Hör-, Lese- und Sprechübungen in Einzel-, Partner- und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Anhand vorgegebener Kriterien und Kommunikationsmuster werden Grundlagen des Referierens und des Diskutierens in der Fremdsprache zu beruflichen Themen vermittelt. Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache B2.2 - Einstieg ins Unternehmen (Seminar, 2 SWS)
Reulein C
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0360: German as aForeign Language B1 – Crossover German: Communication at University and in daily Life | Deutsch als Fremdsprache B1 – Crossover German: Kommunikation an der Uni und im öffentlichen Leben

Version of module description: Gültig ab summerterm 2024

Module Level:	Language:	Duration:	Frequency:
Credits:* 3	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache B1 – Crossover German: Kommunikation an der Uni und im öffentlichen Leben (Seminar, 2 SWS)
Gröbl J
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0361: Projekt Weeks: German as a Foreign Language B2.2 - Sustainability using the example of a national park | Projektwochen: Deutsch als Fremdsprache B2.2 - Nachhaltigkeit am Beispiel eines Nationalparks

Version of module description: Gültig ab winterterm 2024/25

Module Level:	Language:	Duration:	Frequency:
Credits:* 6	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben und E-Tests erbracht. Hilfsmittel sind erlaubt. Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie schriftliche Textproduktion geprüft werden. Wenn im Rahmen einer (Portfolio)Prüfungsaufgabe eine schriftlich ausgearbeitete Präsentation mit mündlichem Anteil erfolgt, z.B. auch in Form einer Audio- oder Videoaufnahme, werden einzelne Aspekte der Mündlichkeit zur Bewertung mit hinzugezogen. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Dieses Modul richtet sich an alle Bachelor- und Master-Studierende der TUM, vor allem aber an Studierende der naturwissenschaftlichen Fächer sowie an Studierende der Management-Studiengänge. Sie haben Kenntnisse der Stufe B2.1, mindestens aber gesicherte Kenntnisse der Stufe B1.2 und bringen Interesse an projektorientiertem Fremdsprachenunterricht mit. Sie verfügen bereits über Methoden und Strategien des selbstgesteuerten Lernens von Fremdsprachen und möchten an fachorientierten, aktuellen Diskursen mit (natur)wissenschaftlichen Bezügen, die nicht unbedingt mit ihrem Studienfach zu tun haben, teilnehmen können. Sie sind darüber hinaus an das Arbeiten in multinational zusammengesetzten Teams gewöhnt und interessieren sich für interkulturelle Fragestellungen.

Content:
In dieser semesterbegleitenden Lehrveranstaltung setzen sich die Studierenden mit dem Thema Nachhaltigkeit am Beispiel eines Nationalparks auseinander. Sie erweitern ihre zielsprachliche Projektkompetenz, indem sie Informationen zu einem selbst gewählten Unter-Thema recherchieren und in Gruppenarbeit und mithilfe von KI weiterführende Fragen für Interviews entwickeln, z.B. mit Personen mit entsprechender Expertise innerhalb und außerhalb der Universität, auf Zoom oder vor Ort im Nationalpark. Dabei trainieren sie wichtige Gesprächstechniken und verbessern ihre mündlichen Fähigkeiten wie auch ihre Mediationskompetenzen, wobei Wortschatz und Redemittel sowie Strukturen der Niveaustufe B2.2 zur Anwendung kommen und gefestigt werden.
Die Inhalte der Recherchen sind interdisziplinär angelegt, so dass die Studierenden über ihr eigenes Studienfach hinaus Einblick in allgemeinsprachliche Diskurse mit (natur)wissenschaftlichen Bezügen bekommen, z.B. der Biologie, der Geographie oder auch des Managements. Als konkrete Unter-Themen bieten sich an: Wasserwirtschaft, Tiermonitoring, Besuchermanagement usw.
Am Ende werten die Studierenden ihre Rechercheergebnisse aus und reflektieren ihre Vorgehensweise und Methoden. Sie vernetzen sich mit einer Arbeitsgruppe aus einem anderen Sprachbereich des TUM Sprachenzentrums, die zu ähnlichen Fragestellungen und zu einem Nationalpark eines anderen Landes recherchiert hat, und erarbeiten gemeinsam eine Präsentation, bei der neben interkulturellen Aspekten auch Mehrsprachigkeit eine Rolle spielt.

Intended Learning Outcomes:
Die Studierenden können zu einem selbst gewählten Nachhaltigkeitsthema im Kontext eines Nationalparks selbständig und in Gruppen recherchieren sowie Fragen für ein Interview mit Personen mit entsprechender Expertise - auch unter Nutzung von KI - vorbereiten. Sie können die Interviews eigenverantwortlich durchführen und auswerten und ihre Vorgehensweise reflektieren, wobei ausgewiesener Wortschatz, Redemittel und Strukturen der Niveaustufe B2.2 ebenso zur Anwendung kommen wie eigenständig erarbeiteter Wortschatz und Strukturen mithilfe von KI. Und sie sind in der Lage, ihre Ergebnisse mit einer Lerngruppe aus einem anderen Sprachbereich zu teilen, sie gemeinsam ansprechend aufzubereiten und dann vor einem breiteren Publikum zu präsentieren. Dabei können sie nicht nur Strategien und Methoden der Mehrsprachigkeit anwenden, sondern auch interkulturelle Fragestellungen mit in den Blick nehmen.

Teaching and Learning Methods:
Die angestrebten Lernergebnisse sollen anhand von gezielten Inputs sowie von Partner- und Gruppenarbeitsphasen, in denen kooperative Lernformen überwiegen, erreicht werden. Dabei werden die Studierenden ermutigt, ihren eigenen Themenwünschen nachzugehen und eigenverantwortlich zu arbeiten. Ein Schwerpunkt des Moduls liegt auf der Vermittlung von kommunikativen Kompetenzen mithilfe von handlungsorientierten Aufgaben, die auch außerhalb des Kursraums zu bewältigen sind. Im Kursraum selbst dienen Simulationen und Rollenspiele dazu, Neu-Erarbeitetes und Gelerntes zu erproben und/ oder weiter zu festigen. Die regelmäßige Reflexion von Lernwegen und Methoden soll schließlich dazu führen, dass die Studierenden im Kontext von Fremdsprachenlernen selbständiger und souverän agieren können.

Media:
Für die Stufe B2.2 entwickeltes Lehr- und Lernmaterial sowie weiteres, multimedial gestütztes Lernmaterial mit Informationstexten, Audios und Videos, z.B. von den Webseiten eines Nationalparks oder von anderen ausgewählten Internetseiten.

Reading List:

Responsible for Module:
Christina Thunstedt Heide Stiebeler

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache B2.2 – Projektwochen: Nachhaltigkeit am Beispiel eines Nationalparks (Seminar, 4 SWS)
Stiebeler H
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0362: German as a Foreign Language B1.1 - Communication in everyday life and internships | Deutsch als Fremdsprache B1.1 - Kommunikation im Alltag und Praktikum

Version of module description: Gültig ab winterterm 2024/25

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 4	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:

Deutsch als Fremdsprache B1.1 - Kommunikation im Alltag und Praktikum (Seminar, 3 SWS)
Reulein C

For further information in this module, please click campus.tum.de or here.

Module Description

SZ0363: German as a Foreign Language C1.2 - Quickly grasping and commenting on complex texts | Deutsch als Fremdsprache C1.2 - Komplexe Texte schnell erfassen und kommentieren

Version of module description: Gültig ab winterterm 2024/25

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 3	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:

Deutsch als Fremdsprache C1.2 - Komplexe Texte schnell erfassen und kommentieren (Seminar, 2 SWS)

Koch H

For further information in this module, please click campus.tum.de or here.

Module Description

SZ0364: German as a Foreign Language B2.1 with Grammar | Deutsch als Fremdsprache B2.1 mit Grammatik

Version of module description: Gültig ab winterterm 2024/25

Module Level:	Language:	Duration:	Frequency:
Credits:* 4	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache B2.1 mit Grammatik (Seminar, 3 SWS)
Schlömer A
For further information in this module, please click campus.tum.de or here.

Module Description

SZ04106: English - Poetry for Engineers C1 | Englisch - Poetry for Engineers C1

Version of module description: Gültig ab summerterm 2024

Module Level:	**Language:** English	**Duration:** one semester	**Frequency:** irregularly
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

SZ04107: English - Key Issues in Business and Technology B2 + C1 | Englisch - Key Issues in Business and Technology B2 + C1

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
This course assesses reading, listening, speaking and writing abilities based on:
- 2 graded assignments for a total of 50%
- presentation on a current topic related to the themes dealt with in the course (including visual aids) 25%
- final written examination 25% based on topics and materials discussed in class.

Duration of the final examination: 60 – 90 minutes minutes.
Resources that may be used to aid the completion of the abovementioned portfolio-components will be determined as per the nature of the individual task.

Repeat Examination:

(Recommended) Prerequisites:
This is course is taught at the B2 and C1 levels. Students need to complete the placement test before the first lesson.

Content:
This course focuses on improving communication skills and integrates reading, listening, speaking and writing with vocabulary and grammar, as needed by the specific group. The subject matter consists of a wide range of current issues, for example sustainability and AI. Students will have many opportunities to explore, critically discuss, present, and write about these, as well as other business- and technology related topics that are most interesting to them.

Intended Learning Outcomes:
After completion of this course, students will be able to understand complex texts and audio-material on current business and technology related topics, critically analyse these and effectively communicate their ideas based on these in English to an international audience.

Teaching and Learning Methods:
Communicative and skills-oriented approach to topics with use of group discussion, reading and listening exercises, pair and group tasks, presentations etc. Students will need to complete regular homework tasks.

Media:
moodle.tum.de

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - Key Issues in Business Today: From AI to Sustainability B2 (Seminar, 2 SWS)
Bhar A

Englisch - Key Issues in Business Today: From AI to Sustainability C1 (Seminar, 2 SWS)
Bhar A
For further information in this module, please click campus.tum.de or here.

Module Description

SZ04108: English - Professional English for Business and Technology C1 | Englisch - Professional English for Business and Technology C1

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Performance, testing the learning outcomes specified in the module description, is examined by a cumulative portfolio of competence and action-oriented tasks which include:
- 2 assignments for a total of 50%
- presentation on a current business related topic (including visual aids) 25%
- final written examination 25% based on topics and materials discussed in class.

As the course may be offered in various formats (online or classroom) the form and conditions of the final exam (with or without aids) will vary. Where audio or video is recorded, we observe the Basic Data Protection Regulation (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Ability to begin work at the C1 level of the GER as evidenced by a score in the range of 60 – 80 percent on the placement test at www.moodle.tum.de. (Please check current announcements as the exact percentages may vary each semester.)

Content:
This course focuses on professional communication skills and integrates reading, listening, speaking and writing with vocabulary and grammar, as needed by the specific group. The subject matter consists of a wide range of current issues in the business world, ranging from ethics and sustainability to leadership and diversity. Students will have many opportunities to explore, critically discuss, present, and write about these topics and other business- and industry-relevant topics that are most interesting to them.

Intended Learning Outcomes:
After completion of this module, students will be able to understand complex texts on current business-related topics, critically analyse these and effectively communicate their ideas based on these in English to an international audience.

Corresponds to C1 of the CER.

Teaching and Learning Methods:
Communicative and skills-oriented approach to topics with use of group discussion, reading and listening exercises, pair and group tasks, presentations etc. Students will need to complete regular assignments.

Media:
Textbook, use of www.moodle.tum.de, online learning resources, presentations, film viewings and audio practice.

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - Professional English for Business and Technology C1 (Seminar, 2 SWS)
Lemaire E
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0527: French A2.1 + A2.2 | Französisch A2.1 + A2.2

Version of module description: Gültig ab winterterm 2023/24

Module Level:	Language:	Duration:	Frequency:
Credits:* 6	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Französisch A2.1 + A2.2 (Seminar, 4 SWS)
Perconte-Duplain S
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0528: French C1 - oral and written expression | Französisch C1 - s'exprimer à l'écrit comme à l'oral

Version of module description: Gültig ab winterterm 2023/24

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 3	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Französisch C1 - s'exprimer à l'écrit comme à l'oral (Seminar, 2 SWS)
Perconte-Duplain S
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0722: Japanese B2 Communication | Japanisch B2 Kommunikation

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:** irregularly
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhaltet Aufgaben zur Anwendung von Schriftzeichen, Wortschatz und Grammatik, zu Lese- und Hörverstehen sowie zur freien Textproduktion und wird in Form von kompetenz- und handlungsorientierten (Portfolio-)Prüfungsaufgaben abgehalten. Hilfsmittel erlaubt. Mündliche Reaktionsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Gesicherte Kenntnisse der Stufe B1

Content:
Im Modul B2 Kommunikation haben die Studierenden die Möglichkeit, gemeinsam mit japanischen Studierenden der Partneruniversität über aktuelle Themen zu diskutieren und ihre sprachlichen sowie interkulturellen Fähigkeiten auszubauen. Dabei werden sowohl Mediationskompetenzen als auch Lernerautonomie gefördert. Darüber hinaus werden anhand der aktuellen Materialien fachspezifische Begriffe und Themen vermittelt, die es den Studierenden ermöglichen, auf wissenschaftlicher Ebene Diskussionen zu führen und Präsentationen zu halten.

Intended Learning Outcomes:
Nach Abschluss dieses Moduls kann der/die Studierende über verschiedene Themen aus seinen/ihren Interessens- oder Fachgebieten Präsentationen halten und seinen/ihren Standpunkt vertreten. Er/sie ist in der Lage, mit Gesprächspartnern aus anderen Kulturräumen adäquat und verständnisvoll zu kommunizieren.

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; Gezielte Hör-, Lese-, Schreib- und Sprechübungen; Einzel-, Partner- und Gruppenarbeit; Förderung kooperativen Lernens; Eigenständiges Referieren; moderierte (Rollen-) Diskussionen.
Freiwillige Hausaufgaben (zur Vor- und Nachbearbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial

Reading List:
Vom Kursleiter selbst angefertigte/zusammengestellte Arbeitsblätter, (online-) Materialien.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

SZ1016: Swedish B1.1 | Schwedisch B1.1

Version of module description: Gültig ab summerterm 2024

Module Level:	Language:	Duration:	Frequency:
Credits:* 3	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Schwedisch B1.1 (Seminar, 2 SWS)
Dai Javad P
For further information in this module, please click campus.tum.de or here.

Module Description

SZ1235: Spanish C1.2 | Spanisch C1.2

Version of module description: Gültig ab summerterm 2024

Module Level:	Language:	Duration:	Frequency:
Credits:* 3	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

LS10008: Business Law | Agrar- und Wirtschaftsrecht

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung besteht aus einer 2-stündigen (120 min.) Klausur, in der die Studierenden ggf. unter Zuhilfenahme der vermittelten Gesetzestexte unterschiedliche Verständnisfragen zu den vermittelten Rechtsbereichen (Ziviles und Öffentliches Recht) beantworten und kurze Sachverhalte aus dem Bereich der Agrar- und Landwirtschaft aus zivil- und öffentlich-rechtlicher Sicht selbstständig lösen müssen. Die Beantwortung der Fragen und Fälle erfordert eigene Formulierungen sowie die Darstellung der sich in betrieblicher wie persönlicher Hinsicht aus den Sachverhalten ergebenden rechtlichen Konsequenzen. Durch die Klausur belegen die Studierenden, dass sie die wesentlichen Kernbereiche der einzelnen Rechtsthemen sowie die entsprechenden Gesetzestexte verstanden haben und auch in der Praxis umsetzen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Innerhalb des Moduls werden wichtige Rechtsbereiche sowohl des öffentlichen wie auch des privaten Rechts vorgestellt. Ziel der Veranstaltung ist, den Studierenden Grundkenntnisse der unterschiedlichen Rechtsbereiche zu vermitteln, mit denen sie später beruflich in Berührung kommen können, u. a.:
- Grundzüge des Kaufrechts;
- Grundzüge des Grundstückserwerbs- und Grundstücksverkehrsrechts;
- Grundzüge des Mietrechts;
- Grundzüge des Pachtrechts mit Schwerpunkt Landpachtrecht;
- Grundzüge des Erbrechts;
- Grundzüge der Stellvertretung;

- Grundzüge des Handels- und Gesellschaftsrechts;
- Grundzüge des Delikts-, Produkthaftungs- und Umwelthaftungsrechts;
- Einführung in die Vertragsgestaltung und Vertragsverhandlung;
- Grundzüge des Dünge- und Pflanzenschutzrechts;
- Grundzüge des landwirtschaftlichen Baurechts;
- Grundzüge des Rechts der Bauleitplanung;
- Grundzüge des Rechts der Flurneuordnung;
- Grundzüge des Naturschutzrechts;
- Grundzüge des Immissionsschutzrechts
- Grundzüge des Wasserrechts.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, verschiedenste Sachverhalte aus dem Bereich der Agrar- und Landwirtschaft aus zivil- und öffentlich-rechtlicher Sicht zu verstehen. Dabei können sie die Grundzüge dieser Rechtsbereiche beschreiben. Die Studierenden können die sich in betrieblicher wie persönlicher Hinsicht aus den agrar- und landwirtschaftlichen Sachverhalten ergebenden rechtlichen Konsequenzen darstellen. Darüber hinaus sie sind in der Lage, Fallbeispiele mit kurzen Sachverhalten unter Verwendung der entsprechenden Gesetztestexte selbstständig zu lösen.

Teaching and Learning Methods:
Die Modulinhalte werden in Form einer Vorlesung vermittelt, mit der den Studierenden zunächst die Grundzüge der einzelnen Rechtsbereiche vermittelt werden. Die Studierenden wenden die vermittelten Kenntnisse bei der Lösung kleiner Fälle an. Mittels Fragen und gemeinsamer Diskussionen werden seitens der Studierenden bestehende offene Punkte beleuchtet und geklärt, womit die vermittelten Inhalte vertieft werden.

Media:
Power-Point, Skripten, Fallbeschreibungen, Fälle und Lösungen.

Reading List:
Jos Mehrings: Grundzüge des Wirtschaftsprivatrechts, 3. Aufl. 2015; José Martínez: Agrarrecht, 1. Aufl. 2020;
Christian Grimm, Roland Norer: Agrarrecht, 4. Aufl. 2015; Christian Busse: Agrarrecht, 1. Aufl. 2020

Responsible for Module:
Michael Kugler Michael.Kugler@freihof-partner.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

LS10038: Agroecological Field Methods | Agrarökologische Feldmethoden

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Jede/r Studierende erbringt die Prüfungsleistung in Form eines Berichts (Inhalt: Methodenbeschreibung, Anwendungsbeispiel, Diskussion, Alternativen; Umfang: 10 Seiten) und einer ergänzenden Präsentation (Dauer: 20 min) zu einer der durchgeführten Methoden. Die Gesamtnote besteht 50 % aus dem Bericht und 50 % aus der Präsentation.
Die Studierenden zeigen hierbei, dass sie bestimmte agrarökologische Untersuchungen mit geeigneten Methoden durchführen können. Zu diesen Methoden gehören sowohl klassische Methoden (z. B. Bodenuntersuchungen, Baum- bzw. Pflanzenbonitur) als auch neue moderne Methoden (z. B. Tea Bag Methode, DNA Analysen). Dabei wird geprüft, ob die Studierenden grundlegende Kenntnisse zu den agrarökologischen Feldmethoden erworben haben. Die Studierenden weisen weiterhin nach, dass sie die unterschiedlichen methodischen Ansätze für Untersuchungen in Agrarökosystemen kennen, verstehen und kritisch beurteilen können, um geeignete Methoden auszuwählen sowie diese in theoretischen Fallbeispielen anwenden zu können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Pflanzenbau und Pflanzenernährung, Agrarökosysteme, Ökologischer Landbau (Bachelorstudiengang Agrarwissenschaften und Gartenbauwissenschaften oder vergleichbare Studiengänge)
Nährstoffkreisläufe in Agrarökosystemen, Geoinformationssysteme und Modellierung, Innovationen für Agrarsysteme (Masterstudiengang Agrarsystemwissenschaften)

Content:
Agrarökologie als Wissenschaft ist ein Teil der Ökologie oder Landschaftsökologie. Ziel ist, zu einer nachhaltigen Landwirtschaft, die biologische Vielfalt erhält und fördert und die landwirtschaftliche Ökosysteme widerstandsfähiger macht, beizutragen. Agrarökologie untersucht daher Wechselwirkungen und Synergien zwischen Pflanzen, Tieren, Boden, Umwelt und dem Agrarökosystem. Sie befasst sich mit den ökologischen Zuständen und Prozessen der Agrarökosysteme.
Anhand von laufenden Dauerfeldexperimenten zu aktuellen Forschungsfragen in den Versuchsstationen Viehhausen und Roggenstein werden agrarökologische Themen und Untersuchungen vorgestellt und auch teilweise von Studierenden durchgeführt. Dazu werden verschiedene Methoden (z. B.: Bodenbeprobung, Tea Bag Index Methode, Regenwurmextraktion, Köderstreifen usw.) praktisch angewandt und kritisch mit anderen Methoden anhand von Literaturrecherchen verglichen.
Auf folgende Aspekte wird im Detail eingegangen:
- Vorstellung von agrarökologischen Themen mit Schwerpunkt Agroforstsysteme und Ökolandbau
- Vorstellung von agrarökologischen Untersuchungsmethoden
- Durchführung und Auswertung bestimmter agrarökologischer Forschungsmethoden
- Ausarbeitung von Methodenbeschreibungen und Verständnis möglicher Anpassungen
- Kritische Betrachtung und Vergleich der durchgeführten Methoden mit alternativen Methoden anhand von Literaturrecherchen
- Auswertung und Interpretation der Ergebnisse

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme sind die Studierenden in der Lage,
- grundlegende Herausforderungen der agrarökologischen Untersuchungen unter Feldbedingungen (z.B. Ressourcenverfügbarkeit, Untersuchungsaufwand, etc.) zu erkennen und detailliert zu beschreiben,
- verschiedene Parameter aus den agrarökologischen Schwerpunktthemen (z.B. Agroforstsysteme, Biodiversität, Ökolandbau) mit verschiedenen Ansätzen zu untersuchen,
- geeignete Forschungsfragen auszuwählen und zu formulieren,
- methodische Ansätze der Felduntersuchungen darzustellen sowie für die Forschungsfragen geeignete Methoden (sowohl klassische Methoden (z. B. Bodenuntersuchungen, Baum- bzw. Pflanzenbonitur) als auch neue moderne Methoden (z. B. Tea Bag Methode, DNA Analysen)) auszuwählen und einzusetzen,
- ihre Ergebnisse zu interpretieren und auszuwerten sowie die eingesetzten Methoden und die Ergebnisse kritisch zu diskutieren.

Teaching and Learning Methods:
Die Modulveranstaltung besteht aus einer Vorlesung (2SWS) und Übungen (2 SWS).
Im Rahmen der Vorlesung wird ein Überblick zu den grundlegenden Herausforderungen der agrarökologischen Untersuchungen gegeben sowie unterschiedliche methodischen Ansätze vorgestellt, um diesen Herausforderungen zu begegnen. Es erfolgt eine detaillierte Vorstellung der laufenden Versuche. In der Vorlesung werden Dauerversuche zu aktuellen Forschungsfragen einbezogen.

Im Rahmen der Übung werden innovative Untersuchungsmethoden vorgestellt. Diese Methoden werden von den Studierenden dann praktisch angewandt. Im Feld gewonnene Proben werden von Studierende aufbereitet und ausgewertet. Die verschiedenen Methoden (Ziel, Fragestellung, Material und Methoden, Vor- und Nachteile und Alternativmethoden) werden in Gruppenarbeit durch die Studierenden über Poster und Folien vorgestellt. Zum Wissensaustauch werden die Gruppenergebnisse mit den anderen Gruppen diskutiert.
Durch diese Lehrveranstaltung gewinnen die Studierenden nicht nur theoretische Kenntnisse, sondern lernen auch, wie agrarökologische Untersuchungen praktisch durchgeführt werden.
Der ganze Prozess (Wahl und Vorbereitung der Beprobungsmethodik, Datenerhebung, Probenbearbeitung, Ergebnisdarstellung und Interpretation) wird durch die Studierenden begleitet.

Media:
Vorlesungspräsentationen, wissenschaftliche Publikationen und sonstige Materialien wie DIN-Normen, Laborhandbücher oder Konzeptpapiere werden bereitgestellt

Reading List:
Gliessman, S. R., V. E. Méndez, V. M. Izzo, and E. W. Engles. 2023. Agroecology: Leading the transformation to a just and sustainable food system. Boca Raton, FL: CRC Press/Taylor&Francis Group.
Hill, David A. (Hg.) (2007): Handbook of biodiversity methods. Survey, evaluation and monitoring. 4. print. Cambridge: Cambridge University Press.
Martin, Konrad; Sauerborn, Joachim (2006): Agrarökologie. Stuttgart, Deutschland: UTB GmbH.
Tittonell, Pablo (2023): A Systems Approach to Agroecology. 1st ed. 2023. Cham: Springer Nature Switzerland; Imprint Springer.

Responsible for Module:
Chmelikova, Lucie, Dr. lucie.chmelikova@mytum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WI001191: Analysis and transformation of nutritional systems | Analyse und Transformation von Ernährungssystemen

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer 120-minutgen Klausur erbracht. In der schriftlichen Prüfung werden die Studierenden die Konzepte, Dimensionen und methodischen Ansätze in Ernährungssicherheit, Ernährungsverhalten und Ernährungspolitik beschreiben und die Auswirkungen verschiedener Ernährungsinterventionen analysieren. Darüber hinaus werden die Studierenden verschiedene Aspekte der Ernährungsverhältnisse und deren Auswirkungen auf verschiedenen Produktionsysteme beurteilen. Zusätzlich werden Modelle verschiedener Disziplinen vergleichen, die zur Entwicklung neuer methodischen Ansätze im Bereich Ernährungsökonomie beitragen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen im Bereich von Mikroökonomie, Management und Marktlehre

Content:
Das Modul beschäftigt sich mit den theoretischen Konzepten und methodischen Ansätzen in Ernährungsökonomie und Nahrungsmittelsysteme. Spezifische Themen in diesem Modul sind:
• Ernährungsökonomie mit dem Fokus auf Ernährungsverhalten und Nahrungsmittelsysteme: Konzepte und Dimensionen
• Verbindungen zwischen Produktionssystemen und Ernährungsverhalten und -sicherheit.
• Marktstruktur, Marktverhalten, organisatorische Formen und Leistungen von Nahrungsmittelsystemen
• Ernährungspolitik, -strategien und -interventionen
• Methodische Ansätze zur Erklärung und Evaluierung von verschiedenen Aspekten der Ernährungs- und Nahrungsmittelsystemen

• Aktuelle Themen, Herausforderungen und exemplarische Darstellungen und Beschreibungen von Nahrungsmittelsystemen und Ernährungsverhalten

Intended Learning Outcomes:
Nach Absolvieren des Moduls sind die Studierenden in der Lage,
• die theoretischen Konzepte und Veränderungsprozesse der Ernährung und Nahrungsmittelsysteme auf lokaler, regionaler und globaler Ebene zu verstehen,
• die Organisationsstrukturen, Marktverhalten und ernährungsbezogene Leistungen von verschiedenen Nahrungsmittel- und Produktionssystemen kritisch darzustellen,
• Ernährungsinterventionen und die Verbindungen zwischen verschiedenen Produktionssystemen, Ernährungssicherheit und Ernährungsverhalten zu analysieren,
• verschiedene Aspekte der Ernährungsverhältnisse und dazu gehörige Marktverhältnisse und Leistungen der Produktionssysteme zu evaluieren, und
• relevante weitere sozio-ökonomischen Modelle im Ernährungsbereich zu entwickeln

Teaching and Learning Methods:
Mit Hilfe der Vorlesung werden die Konzepte, Dimensionen und methodische Ansätze der Ernährungsverhältnisse und –sicherheit sowie die Verbindungen mit Produktionssystemen und dazugehörige Marktverhältnisse und Ernährungsinterventionen vermittelt. Einzelarbeiten, Gruppenarbeiten und Präsentationen werden zum Bearbeiten von ernährungsbezogenen Leistungen der verschiedenen Produktionssysteme und dazugehörige Marktverhalten und Organisationsstrukturen benutzt.

Media:
Präsentationen, Fallbeschreibungen, Skripte

Reading List:
Allen, S. and de Brauw, A. (2018). Nutrition sensitive value chains: Theory, progress, and open questions. Global Food Security, 16: 22–28
Babu, S.C. et al. (2016). Nutrition Economics: Principles and Policy Applications. New York.
Carlton, D.W. and Perloff, J.M. 2005. Modern Industrial Organization. Fourth edition. New York.
Davis, G. C. and López Serrano, E. (2016). Food and nutrition economics: fundamentals for health sciences. Oxford: Oxford University Press.
Gyles, C. et al. 2012. Health economics and nutrition: a review of published evidence. Nutrition Reviews, 70(12):693–708
Just, D.R. (2006). Behavioral Economics, Food Assistance, and Obesity. Agricultural and Resource Economics Review, 35(2): 209-220
Herforth, A. and Ballard, T. (2016). Nutrition indicators in agriculture projects: Current measurement, priorities, and gaps. Global FoodSecurity 10: 1–10
Lenoir-Wijnkoop, et al. (2013). Nutrition economics – food as an ally of public health. British Journal of Nutrition, 109: 777–784

Pandey, V. L. et al. (2016). Impact of agricultural interventions on the nutritional status in South Asia: A review. Food Policy 62: 28–40

Die Liste wird anhand von weiteren thematisch relevanten Büchern, Zeitschriftenartikeln und aktuellen Themen aktualisiert

Responsible for Module:
Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0608: Automated Agricultural Machines - Lab course | Automated Agricultural Machines - Lab course

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination takes the form of an exercise performance. It comprises short written tests, programming tasks and a final oral test. In three written tests (10 minutes duration, no permitted aids), the students can prove and apply their acquired knowledge. The content of the tests could for example contain the completion of a program code with gaps, calculations of measurement noise metrics or knowledge questions on the theoretical part of the course. By completing a programming task, students demonstrate their ability to implement the theory of the course with the programming tools provided. The oral test takes place at the end of the course (15 minutes duration, no permitted aids). Students should answer questions related to the theory and implementation aspects of the programming tasks of the complete course. Within the oral examination, students can thus demonstrate their understanding of the required implementation and interpret advantages and limitations of the proposed solutions. Moreover, the students should be able to explain necessary extensions, if the objective of the programming task is slightly altered.

Current information with regards to the restricted attendance due to the CoViD19 pandemic: If the framework conditions (hygiene, distance rules, etc.) for an attendance examination are not available, the planned examination can be changed to an online-supported exercise performance (3 e-tests, 1 oral test via video) in accordance with
§13a APSO. The decision on this change will be announced as soon as possible, but at the latest 14 days before the examination date by the examiner after consultation with the responsible examination board.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic skills of programming

Basic skills in calculus

Content:
The practical course is intended to introduce the students to technical tools and methodology associated with automation, control, positioning and navigation in agricultural machines. By attending the practical course, the participants should be able to solve basic automation tasks independently. To this end, the necessary theoretical background (e.g. algorithms, interfaces, control systems) is taught in the course and application-oriented tasks are set for the students. These tasks are then solved by the students themselves in life sessions. In the end, not only the solution to the concrete application is learned by the student, but the general programming method. Moreover, students learn to analyse the behaviour of automation systems with common metrics with the help of mathematical programming tools. Throughout the course, MATLAB is used for most of the programming and evaluating. Moreover, the course is designed to incorporate software including Notepad++, QGIS and others.

The practical course is divided into multiple exercises which are loosely coupled. Each exercise consists of three blocks. The first block contains a self-study phase of pre learning material. The material is provided by the lecturer in advance and can for example include publications, hardware documentations or book chapters. The goal is to introduce the students to the exercise topic and provide a general overview of solution strategies. The second block is a presentation by the lecturer during the exercise session. The lecture summarizes the topic and provides additional background and hints for the following tasks. The third part consists of the actual tasks for the students to be solved, e.g. programming, measuring or calculating. Some exercise sessions also involve the interaction with a real vehicle to collect data for programming problems or to test their own software. Besides individual work, students are supposed to collaborate as self-organized teams. Throughout the exercise, the lecturer is available and continuously guides the students. Finally, the individual solutions to the tasks are discussed with the lecturer and conclude the exercise.

Individual exercises may change from year to year, to follow the latest trends in agricultural automation and the latest equipment available.

Intended Learning Outcomes:
After participating in this practical module, students are able
- to remember the automation techniques used in modern agricultural machines
- to remember the data interface structures used in agricultural automation, including XML
- to understand guidance methods of off-road vehicles
- to solve calculation exercise for agricultural automation tasks
- to analyse measurement data from positioning devices
- to evaluate solution strategies for agricultural automation tasks
- to create simple software programs for automation in agriculture
- to plan experiments to assess the quality of automated tasks within agricultural machines

Teaching and Learning Methods:
The main content is taught in practical exercise sessions, which are loosely interconnected. Before each exercise sessions, the students should study pre-materials provided in written form. The pre-materials help the students to understand the basic terminology and concept related to the context of the practical exercise. In each exercise session, the teacher presents content related to the exercise tasks. Students are supposed to solve the tasks e.g. by implementing programs in their own computer and are guided by the instructor. Moreover, teamwork among students is anticipated to solve some of the tasks in a corporate fashion. An assessment of the obtained solution is either carried out by the instructor or with provided test scenarios during the same session. Some exercises may involve interaction with real machines to collect data or test their software compatibility. In these parts of the exercise it is required for the students to act as a group, e.g. to collect the data together with a coordinated plan.

Media:
Presentations, films, exercise sheets, code snippets, experiments with hardware

Reading List:

Responsible for Module:
Oksanen, Timo; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Automated Agricultural Machines - Lab course (Praktikum, 5 SWS)
Oksanen T [L], Brodie S, Hefele R, Moll M, Oksanen T, Pindl L, Soitinaho R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1467: Transformation management in the company | Transformationsmanagement im Unternehmen

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is an oral examination lasting 30 minutes. Students have to demonstrate their knowledge of the fundamentals of value-oriented management and strategies in the agricultural, building materials and energy sectors. Furthermore, students should show that they can identify entrepreneurial, economic policy and societal challenges on the basis of a specific case study (e.g. world nutrition, digitalization, climate change) and develop solution approaches for these. In doing so, they should show that they can integrate different perspectives and critically evaluate them on the basis of the contributions in the workshop.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of business administration and economics

Content:
The module includes lectures that teach the basics of value-based management and the challenges in agribusiness.
This specific basic knowledge is applied and deepened in a workshop. Complementary to this, the excursions give an
insight into the business world of a trading company.
The lecture is essentially divided into two sections:
In the first part, the fundamentals of value-oriented corporate management (Management & Ethics Parts I-III) are taught:
a. Basics of the current economic system including the historical development of capitalism as well as the emergence of the shareholder value approach and an excursus on member value in cooperatives.

b. Ethical foundations and conflicts in corporate management and challenges from a socio-economic
perspective; e . g. on sustainability, "Green Deal" and corporate social responsibility
c. Role, tasks and challenges of a value-oriented management taking into account global trends
- Effects on management, organizational structure and process organization
- Project and change management
- Communication and Public Speaking Training.

The second part of the lecture is about strategic challenges in management part I and II:
a. Globalization:
- Significance and dimensions of globalization from the perspective of a company
- Strategic management; growth strategies, internationalization, M&A, intercultural management
- Trade flows of products and inputs in the food industry (using fruit as an example)
b. Digitalization: Impact of digital transformation on management; Big Data, Platform Economy, IoT, Work 4.0

As part of the workshop, students are given topics of economic and sociopolitical debate at the beginning of the
semester (e.g., world nutrition, climate change, robotization/digitization, sustainability), which they research and work on in group work and present in the "Debating Club" as a case study. In one excursion, students attend the
annual general meeting of a trading company in Munich that originated from cooperative roots. In a second excursion to
the BayWa headquarters, the so-called "Expertday" will provide insights into the agricultural, construction and energy
sectors and give the basics of diversified management.
The lecture course is complemented with communication/ public speaking training.

Intended Learning Outcomes:
After successful participation in the module, students understand the basics of value-based management, know relevant management methods and are able to understand ethical conflicts caused by the current economic system in the management of different companies, e.g. also cooperatives. Furthermore, participants understand the challenges of global trends on international trade flows in agri-food management and learn strategies in global agribusiness.
Through presentations by active managers from the building materials trade and construction project business as well
as the project business in the renewable energy sector, students learn about the strategic framework and management of other business areas.
Furthermore, they are able to identify social, ethical and ecological conflicts on the basis of specific case studies (e.g. on robotization/digitization, climate change, world nutrition) and to develop entrepreneurial approaches to solving them. In doing so, they learn to integrate different perspectives and to critically evaluate them on the basis of the contributions in the workshop. In addition, they receive communication/rhetoric training and achieve a high level of communicative

competence through discussion contributions. By participating in a field trip, the students are enabled to demonstrate and discuss the course of an annual general meeting of a large company.

Teaching and Learning Methods:
Within the framework of the teaching formats used in the module lecture, workshop (preparation and presentation of a case study) as well as excursions, the teaching methods lecture, presentation and group work are primarily used.
With the help of the lectures, the extensive knowledge of the necessary theoretical basics is imparted. By working on a case study within a "Debating Club", the students deepen and expand their acquired knowledge and apply it within the framework of the workshop. The excursion to the BayWa headquarters provides a good overview of the business world of a trading company and thus represents a practical supplement to the lecture and workshop.

Media:
Powerpoint Presentations, Movies, excercise sheets, etc.

Reading List:
Eichwald B. und Lutz K.: Erfolgsmodell Genossenschaften; Möglichkeiten für eine werteorientierte Marktwirtschaft. Wiesbaden, 2011.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2620: Applications of Evolutionary Theory in Agriculture: Population Genomics of Crop Pathogens and Disease Management | Applications of Evolutionary Theory in Agriculture: Population Genomics of Crop Pathogens and Disease Management

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a written exam (60 min). The students have to answer several questions related to the evolution of pathogens in response to disease management. One case study (with two-three articles) is provided ahead of the examination as preparation. The students have to analyze before the exam the methods used in the studies and the results. In answering the questions at the examination, the students will 2) explain the concepts of Evolutionary genetics applied to disease management of that particular pathogen, 3) describe the theoretical models used in the course which are adapted to explain the results of the studies, 4) evaluate critically the management strategy used in the studies, and 5) propose new better disease management strategies based on the knowledge of the pathogen genomics. Additional references searched by the students before the examination can be added to help answer the question.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in statistics and genetics, additional basic knowledge of phytopathology

Content:
This module covers a profound overview of the evolutionary mechanisms driving the changes in crop pathogen populations and their implications for disease management.
It is built in four major blocks (four topics). They are enclosed by seminar and discussion block where students mobilize their theoretical knowledge to interpret data and propose new disease management strategies for major crops (rice, wheat, barley, banana, maize, apple, tomato).

1) Introduction to evolutionary genomics: we describe the neutral theory of molecular evolution (including genetic drift, random mutation, transposable elements insertion). How is a genome organized? What is the spatial structure of pathogen populations (between fields, regions, and continents). We describe how natural selection acts at the level of major genes and of quantitative traits, and give examples of such genes in crop pathogens. This part is mainly a lecture with small exercise to compute genetic drift using R.

2) Pathogen genomics: range of genome sizes found in pathogens. What is the effect of recombination (sexual reproduction) and accumulation of deleterious mutations by Muller's ratchet. This part is mainly lecture with small exercise on a model of sexual recombination in pathogens.
3) Disease epidemiology: disease epidemiology principles, SIR models, models of disease spread in a field (SEIR), herd immunity concept, evolution of aggressiveness. This block consists of a lecture and long exercise sessions in R where simulations of SIR and SEIR models are performed.
4) Host-parasite coevolution: introduction to models of coevolution, importance of gene-for-gene interactions in plants. We study simple dynamical systems and predict the outcome of coevolution, that is occurrence of arms race or trench warfare dynamics. This part includes a short lecture and exercise sessions with R codes simulating coevolutionary dynamics. Simulations are used to exemplify and understand the possible outcome of coevolution and to understand the implications of deploying major resistance genes in disease management.
Synthesis: what is an optimal disease management taking pathogen evolution into account? This part consists of a lecture and a seminar part (paper presentation) where the students analyze and evaluate critically genomic studies of various crop diseases and the link to disease management strategies.

Intended Learning Outcomes:
The students have a profound understanding of the evolutionary mechanisms driving evolutionary and genomic changes in crop pathogen populations. For example, they can describe how the genomes of pathogens change in time due to coevolution with their host, the action of humans and certain disease management strategies.
Furthermore, the students are able to describe the genome evolution of pathogens and use knowledge from published full genome data analyses of crop pathogens.
The students understand the principles of disease epidemiology. They can build basic mathematical models and implement them in R to perform simulations and analyze their behavior.
The students are able to describe and explain the mechanism of coevolution between hosts and their pathogens. To do so they are able to build a mathematical model of coevolution, analyze its long-term dynamics and implement it in
R. Finally, the students can integrate aspects of pathogen evolution into disease management, and are able to design their own new management strategies for different crop diseases. They have basic skills in coding with the software R and are therefore able to perform basic statistics for plant pathology.

Teaching and Learning Methods:
The lectures and exercises are intermixed during the sessions. Typically, a first part of lecture introduces the concepts and the mathematical models. Then students will implement the model in

R and perform simulations under different parameters. Thereby, they gain a direct understanding of the behavior and outcome of the mathematical model. The exercises are done by the whole group, and students are encouraged to discuss their results with their colleagues, before a summary is presented by the lecturer. There is also a seminar session, where students by groups of two will present a research paper which is a case study of population genomic data of a crop pathogen. The students perform a PowerPoint presentation of this case study and afterwards will discuss it with the lecturer and the other students.
The aim of the presentation is to describe, analyze and interpret population genomic data of crop pathogens, critically evaluate the results and evaluate the efficiency of disease management strategies.

Media:
PowerPoint, computer program R, whiteboard, published articles

Reading List:
Madden, Hughes, and van den Bosch, The Study of Plant Disease Epidemics (2007); Hartl and Clark, Principles of Population Genetics 4th Edition (2007);
Hedrick, Genetics Of Populations 4th Edition (2009);
Otto and Day, A Biologist's Guide to Mathematical Modeling in Ecology and Evolution (2007);
Milgroom, Population Biology of Plant Pathogens: Genetics, Ecology and Evolution. American Phytopathological Society Press (2015)

Responsible for Module:
Tellier, Aurélien; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Applications of Evolutionary Theory in Agriculture: pathogen population genomics and disease management (Vorlesung, 3,3 SWS)
Tellier A [L], Clin P, Tellier A

Applications of Evolutionary Theory in Agriculture: pathogen population genomics and disease management (Seminar, ,7 SWS)
Tellier A [L], Tellier A
For further information in this module, please click campus.tum.de or here.

Module Description

LS20038: Biophysical Plant Physiology | Biophysical Plant Physiology

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination comprises a report (minimum of 5 pages, 65% of the overall grade) and a supplementary presentation including a discussion (15-20 min presentation + 30 min discussion, 35% of the overall grade). Students demonstrate their ability to understand a scientific publication on selected topics of biophysical plant physiology, to evaluate the experimental work, to summarize the publication, and to present it to an audience as well as lead a discussion on the presented scientific work. The presentation is a prerequisite to submit the written report.
The report consists of key sections: 1) Title: should reflect the content and the purpose of the selected study; 2) Summary statement: summarizing the key aspects of the entire report; 3) Introduction: introduce the selected scientific publication/topic and the relevance to biophysical plant physiology, provide background information, state the research questions and the hypothesis; 4) Methods: include information on plant materials, experimental setup, measurements, analytical techniques employed; 5) Results: present the key findings of the study including relevant graphs or figures from the publication; 6) discussion: discuss the significance of the findings, the implication and the identify limitations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Participation in Plant Physiology practical sessions is recommended.

Content:
The following topics are covered:
• Introduction
• Cells and diffusion (Cell structure [Generalized plant cell, Leaf anatomy, root anatomy, vascular tissue], Diffusion [Fick’s law], membrane structure and permeability)

• Water physical properties (surface tension, capillary rise, water potential [matric, hydrostatic, osmotic])
• Water potential and plant cells (pressure-volume curve, incipient plasmolysis)
• Roots and fluxes (root hairs, radial water flow across root [apoplastic, symplastic], radial conductance and resistance)
• Leaves and fluxes (stomata [stomatal conductance and resistance, intercellular air space], CO2 conductances and resistances)
• Plants and fluxes (soil-plant-atmosphere continuum, aboveground and belowground feedback)
• Water use efficiency (WUE; value of WUE, stomatal control of WUE, C3 vs. C4 plants)
• Advanced methodologies in soil-plant interactions.
• Plant response to atmospheric and soil droughts; Open questions and introduction to seminar topics.
• Seminars and discussions of seminal research papers related to the lecture topics.

Intended Learning Outcomes:
After successfully completing the module, students are able to:
• explain and evaluate systematically the drivers of water stress to plants
• explain the dynamics of plant water status for varying environmental conditions and plant traits
• evaluate the biophysical properties of the root-soil interface that impact plant water relations
• describe the biophysical processes of water movement across soil-plant-atmosphere continuum
• critically evaluate current research on plant water relations
• evaluate the current trends in plant water research

Teaching and Learning Methods:
Oral presentations with PowerPoint presentations serving as visual aids, blackboard writing, discussion in class, and students' presentations with discussions

The module consists of 2 SWS lectures and 2 SWS seminars to provide a comprehensive learning experience and achieve the specified learning outcomes. The lectures are crucial for knowledge transfer and foundation building that are essential for understanding the biophysical processes of water movement across the soil-plant-atmosphere continuum. Seminars will offer opportunities for interactive learning, discussion, and applications of the concepts. The combination of both types of courses encourages a holistic understanding of biophysical plant physiology.

Media:
Presentations via PowerPoint, blackboard writing, pdf files of PowerPoint presentations will be uploaded in Moodle

Reading List:
- Physicochemical and Environmental Plant Physiology, by: P. Nobel
- Physiological Plant Ecology: Responses to the Physical Environment, by: O.L. Lange, P.S. Nobel, C.B. Osmond and H. Zeigler
- Plant Physiology, by: L. Taiz and E. Zeiger
- Suggested seminal research articles

Responsible for Module:
Ahmed, Mutez Ali Abdelrahman, Prof. Dr. rer. nat. mutez.ahmed@tum.de Abdalla, Mohanned,Dr. rer. nat mohanned.abdalla@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar on Biophysical Plant Physiology (Seminar, 2 SWS)
Ahmed M, Abdalla M

Biophysical Plant Physiology Lectures (Vorlesung, 2 SWS)
Ahmed M, Abdalla M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1247: Soils of the World | Böden der Welt: Eigenschaften, Nutzung und Schutz

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination is an oral examination (25 min). On the basis of the examination, students show that they know all soil types on earth with their most important properties and understand their genesis and the reasons for their occurrence in different parts of the world. They also show that they can assess the threat to soils from various forms of land use in relation to natural soil (in)fertility. They demonstrate that they can analyze the consequences of land use for the global carbon balance. They show that they are able to assess the specific requirements for the use of different marginal sites. They also demonstrate that they can develop concepts for sustainable production on marginal sites, soil protection, and increasing soil fertility through the use of trees.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Soil science (WZ1825) or comparable courses at other universities

Content:
1. characteristics, distribution, genesis, and utilization possibilities of all soil types on earth, presented according to the international soil classification WRB. 2. the world food problem, what is soil degradation, increasing food production on fertile sites, marginal sites (highly erosion-prone, semi-arid, highly kaolinitic), agroforestry (definitions, effects of trees on the soil, erosion control, water balance, nutrient balance, the role of roots).

Intended Learning Outcomes:
After successfully completing this module, students will be familiar with all soil types on earth and their most important properties. They have understood their genesis and the reasons for their

occurrence in different parts of the world. Students will be able to assess the threat to soils from various forms of land use in relation to natural soil (in)fertility and analyze the consequences of this land use for the global carbon balance. They can develop concepts for sustainable production on marginal sites as well as for soil protection and increasing soil fertility through the use of trees.

Teaching and Learning Methods:
The module consists of two lectures. In the lectures, students are introduced to all soil types on earth with their most important characteristics, their genesis and the reasons for their occurrence in different parts of the world, connections between natural soil (in)fertility and the threat to soils through land use, the production possibilities on sites of different fertility and their historical and cultural implications as well as the possibilities of soil protection through the use of trees in the form of presentations. Using examples, students learn to assess the specific requirements for using different marginal sites.

Media:
Presentations, blackboard notes

Reading List:
1. Zech W, Schad P, Hintermaier-Erhard G (2022): Soils of the World. Springer, Heidelberg.
2. IUSS Working Group WRB (2022): World Reference Base for Soil Resources. 4th edition. International Union of Soil Sciences (IUSS), Vienna, Austria.
3. Blanco, H., Lal, R. (2008): Principles of soil conservation and management.
4. Diamond, J. (2005): Warum Gesellschaften überleben oder untergehen.

Responsible for Module:
Schad, Peter; Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Böden der Welt (Vorlesung, 2 SWS)
Schad P

Bodendegradation und Bodenschutz in den Tropen und Subtropen (Vorlesung, 2 SWS)
Schad P
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1875: Apicultural Sciences | Bienenwissenschaft [Apicultural Sciences]

Version of module description: Gültig ab summerterm 2017

Module Level: Master	Language: German	Duration: one semester	Frequency: summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer mündlichen Einzelprüfung (30 Minuten) erbracht. In dieser soll nachgewiesen werden, dass die funktionellen Zusammenhänge der Bienenhaltung eingeordnet und auf fachspezifische Fragestellungen angewandt werden kann. Darüber hinaus sollen Rückschlüsse auf Konsequenzen für die Bienenzucht gezogen und Forschungsmöglichkeiten diskutiert werden können. Hierbei sollen die Teilnehmer die Fähigkeit zeigen zu strukturieren und das erlernte Wissen auf neue Sachverhalte anzuwenden. Grundlage sind die in den Vorlesungen, wissenschaftlichen Fachexkursionen und entwickelten Forschungsansätze erworbenen Kenntnisse und Kompetenzen.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse der Genetik

Content:
Teil I: Bienenwissenschaft: Internationale Bienenhaltung und weltweiter Handel mit Tieren und Zuchtmaterial, Image der Bienenhaltung national und international, Bienenwissenschaftliche Institutionen, Teildisziplinen der Bienenforschung, Fördermöglichkeiten, Datenbanken;
Teil II: Versuchswesen mit Bienen; Anatomie, Physiologie, Ethologie, Schwarmverhalten, Interaktionen und Abwehrverhalten, spezielle Genetik der Honigbienen, Zuchtmerkmale, Identifizierung von nachzuchtwürdigen Tieren, Selektion und Möglichkeiten zur Anpaarung, Paarungskontrolle, künstliche Besamung, künstliche Befruchtung, Genomik, Proteomik, Epigenetik, Gelee Royal, Honig, Wachs, Krankheiten und deren Bekämpfung;
Teil III: Forschungsansätze: Methoden und Möglichkeiten der Bienenforschung, Datenbanken zur Recherche

Intended Learning Outcomes:
Nach dem Besuch des Moduls sind die Studierenden in der Lage, Bienenhaltung und Bienenhandel zu bewerten, sowie das Versuchswesen mit Bienen nachvollziehen zu können. Sie kennen wichtige physiologische Vorgänge, die wesentlichen anatomischen Merkmale und können Verhalten interpretieren. Die Studierenden sind in der Lage, die Grundlagen der Genetik und Zucht der Honigbiene darzulegen. Sie haben einen Überblick über die wesentlichen Bienenkrankheiten und zeigen Maßnahmen zu deren Bekämpfung auf. Die Teilnehmer beurteilen Beispiele aus der Forschung und können Vorschläge bearbeiten, sowie Themen zu weiteren Forschungsmöglichkeiten herleiten.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung, Praktikum, Exkursionen zu wissenschaftlichen Instituten der Bienenwissenschaft; Lehrmethode: Vortrag und Präsentation, Anleitungsgespräche, Demonstrationen; Lernaktivitäten: Studium von Vorlesungsskript und – mitschrift, Erstellen eines Glossar in Moodle, Entwicklung und Präsentation eines Forschungsansatzes zur Bienenwissenschaft, Recherche; Zusammenarbeit mit anderen Studierenden über die Lernplattform Moodle. Um eine Verknüpfung zwischen Vorlesung und Praxis zu fördern, sind Unterweisungen im Labor Teil der Veranstaltung. In Gruppenfeedbacks werden die Schwerpunkte aus Papern erarbeitet, um die Studierenden zu aktivieren.

Media:
Präsentationen mittels Powerpoint, englischsprachigen Veröffentlichungen, Flipchart, Skript (Downloadmöglichkeit für Vorlesungsmaterial), Videos

Reading List:
Skript der Lehrveranstaltung, ergänzende Literaturangaben während der Vorlesung

Responsible for Module:
Hans Rudolf, Prof. Dr. agr. Habil. Fries ruedi.fries@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung
Wiecha, Jochen Georg
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1037: Crop Physiology | Crop Physiology - Ertragsphysiologie

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The assessment of this module consists of an oral exam (30 min.). Students have to demonstrate that they can apply the acquired knowledge in plant physiology to possible reactions of plants to changing environments like increasing CO2 concentrations, heat and drought stress, variable N supply etc. They have to show that they captured the basic concepts of plant physiology with emphasis on C economy. It will be assesed if students have acquired an adequate understanding of the interactions of different plant ressources like water, light, CO2 and nutrients.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of cell biology, biochemistry, molecular biology as well as physics, chemistry at bachelor level.

Content:
Aspects of crop physiology like C economy (photosynthesis and respiration), N economy (uptake, distribution, the concept of Ncrit), plant water relations, light interception, growth and development

Intended Learning Outcomes:
After a successful participation the students will be able to:
- understand the basic mechanism of the photosynthesis, and in particular to understand the differences of the photosynthesis types C3 and C4
- understand the C economy (emphasis on photosynthesis and respiration), water relations, and N economy of plants
- understand and evaluate the impacts of quantity and quality of growth factors such as CO2, water, light, and nutrients

- use this knowledge to comprehend canopy and yield development of crops and grassland, including light absorption and interception, N uptake and distribution as well as growth processes like cell division and elongation
- apply methods of plant physiology research (gas exchange measurements; stable isotopes) and evaluate and interpret the produced data

Teaching and Learning Methods:
The basic plant physiological process are presented in lectures (2 SWS), complemented by examples of state-of-the-art research. An accompanying practical course (2 SWS) demonstrates methods of plant physiological research, which are executed by the students.

Media:
Presentation as lectures, handout of the lecture content as pdf

Reading List:
Lecture handouts; current scientific publications

Responsible for Module:
Schäufele, Rudolf; Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Ertragsphysiologie - Crop Physiology (Übung, 2 SWS)
Schäufele R

Ertragsphysiologie - Crop Physiology (Vorlesung, 2 SWS)
Schäufele R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1590: Climate Change Economics | Climate Change Economics

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
There will be a written exam (Klausur) of 90 minutes at the end of the semester. The students will be asked to demonstrate, within the stipulated amount of time using predefined methods and resources, their ability to outline the challenges climate change poses to regulators, propose pragmatic solutions and strategies as well as ways of implementing them. This will be based on the competencies acquired from the relevant literature of economic modeling, theories of climate change, and their understanding of the course content. The written exam is an appropriate assessment method to evaluate the degree to which the students understand the theoretical framework of climate change implications as well as provides an opportunity for them to put forward arguments based on existing theory.

In addition, there is the option of taking a voluntary mid-term assignments as course work in accordance with APSO §6, 5. For this, a presentation (15 min) has to be given.
The module grade can be improved by 0.3 by passing the course work if this better characterises the student's performance level on the basis of the overall impression and the deviation has no influence on passing the examination. No repeat date is offered for the mid-term performance. When retaking a failed module examination at the next possible examination date, successfully passed mid-term assignments will be taken into account.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge:
• Micro Economics (Welfare Economics)
• Environmental Economics
• Resource Economics

Content:
This course covers the trends in current and future climate change and their effects on economic and social outcomes.

The lectures cover the following topics:
1. Introduction to the Basic Science of Climate Change
- The students will learn about the scientific themes of global climate change and the economic dimension of the phenomenon.
2. Basic Economics
- The students will learn how a market economy can be efficient and socially optimal as well as about the prospects of externality.
3. Optimal Emission Levels
- The students will learn of the optimal abatement path and its uncertainty with respect to damages as well as Integrated Assessment Models (IAMs).
4. Intra-generational equity in climate policy
- The students will learn about how to account for equity across space (intergenerational equity) when deriving optimal emission levels.
5. International Environmental Agreements
- The students will learn about the dynamics behind common strategies towards achieving some form of optimal emission level.
6. Policy Instruments
- The students will learn about diverse instruments such as quality-based approach and Pigouvian Tax.
7. Regulation via Prices vs. Quantities
- The students will learn what circumstances will a regulator prefer prices over quantities and vice versa.
8. Credit-based Mechanisms
- The students will learn about how to deal with countries that do not want to commit but have a high potential for low-cost reductions.
9. German Climate Policy
- The students will learn about German Climate Action - strategies and policies
10. European Union Emission Trading Scheme - EU ETS

Intended Learning Outcomes:
After successfully completing the module, students are able to:
• Evaluate economic models related to climate change.
• Understand theoretical models of climate change regulations as well as policies that affect emission levels.
• Comprehend the complexity, uncertainty and possibilities associated with optimal emission level.
• Analyze appropriate instruments for emission levels that are efficient and cost-effective.
• Understand different forms of climate agreements and climate action strategies that are currently being implemented

Teaching and Learning Methods:
The course consists of lectures (2 SWS) and seminars (2 SWS). The lecture forms the basis for the subsequent discussion within the seminar on climate change issues from an economic perspective. The content of the module is expected to be transferred to the students in an interactive learning manner (including discussions in the lectures but especially intensive discussions in the seminar) where, among others, emission reduction instruments are scrutinized. This encourages the students to independently and self-reliantly study the literature guided by a structured framework.

Media:
PowerPoint, flipchart, internet portals, online reports etc.

Reading List:
Bréchet, T., & Eyckmans, J. (2009). Coalition theory and integrated assessment Modelling: Lessons for climate governance. Global Environmental Commons: Analytical and Political Challenges in Building Governance Mechanisms.
Rohling, M., & Ohndorf, M. (2012). Prices vs. quantities with fiscal cushioning. Resource and Energy Economics, 34(2), 169-187.
MacKenzie, I. A., & Ohndorf, M. (2012). Optimal monitoring of credit-based emissions trading under asymmetric information. Journal of regulatory economics, 42(2), 180-203.
Hake, J. F., Fischer, W., Venghaus, S., & Weckenbrock, C. (2015). The German Energiewende–history and status quo. Energy, 92, 532-546.
Climate Action Plan 2050 Principles and goals of the German government's climate policy. https://www.bmu.de
/fileadmin/Daten_BMU/Pools/Broschueren/klimaschutzplan_2050_en_bf.pdf
EU ETS Handbook. https://ec.europa.eu/clima/sites/clima/files/docs/ets_handbook_en.pdf

Responsible for Module:
Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1696: Crop Genomics | Crop Genomics

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam (90 min, Klausur) students explain without additional helping material the principles of genetic and bioinformatics strategies of genome analysis in crop plants. They demonstrate that they understand the different layers of genome analysis in crop plants, and that they are able to apply the required genomic and bioinformatics approaches in case studies and judge which methods can be applied in specific cases. They can explain the use of genomic data to analyze genotype-phenotype associations. The grade of the exam will be the final grade of the module.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful completion of Bachelor's courses in genetics, molecular biology, plant breeding and statistics is required. Basic knowledge in bioinformatics and skills in R programming or a computer language like Python is highly recommended.

Content:
- Genome organization in crop plants (theory)
- Next generation sequencing and genotyping technologies (theory)
- Genome sequencing and annotation (theory)
- Accessing biological sequence information from databases (theory, exercises)
- DNA sequence comparison and alignment, homology searches (theory, exercises)
- Analysis of genomic sequence data, detection of sequence variants (theory, exercises)
- Analysis of gene expression through genome-wide approaches (theory, exercises)
- Comparative genome analysis (theory)
- Genotype-phenotype association for complex agronomic traits (theory, exercises)
- Application of genomic methods in applied plant breeding programs (theory)

Intended Learning Outcomes:
Upon successful completion of the module students are able to evaluate molecular methods and the bioinformatic and genetic concepts of genome analysis in crops. They understand the genome organization of crop plants and can explain the concepts of next generation genome sequencing, genome annotation and functional analysis of crop plants. They are able to access biological sequence information from databases and understand the concept of DNA sequence comparison and alignment. Students are able to analyze plant genomics data and to use bioinformatic/statistical approaches for the analysis of genotype-phenotype associations. Successful students can judge which approaches are appropriate for specific situations.

Teaching and Learning Methods:
Theoretical concepts are demonstrated in PowerPoint presentations. Practical application of these concepts will be through computer exercises and tutorials using experimental data sets. Students show their ability to understand and solve problems using current literature and to analyze and evaluate the required methods with presentations.
Students are encouraged to attend the weekly talks of the SFB924 seminar series (dates and topics announced under http://sfb924.wzw.tum.de), which are given by national and international experts in plant molecular biology and plant genomics.

Media:
PowerPoint presentations, whiteboard. Lecture slides will be provided online in pdf format.
Computer exercises, application training (analysis of sequence data, genotype-phenotype associations)
Current literature

Reading List:
Brown: Genomes 4. Garland Science, 2017. ISBN 978-0-815-345084
Grotewold, Chappell and Kellogg: Plant Genes, Genomes and Genetics. Wiley-Blackwell, 2015. ISBN: 978-1-119-99887-7

Current literature from specific journals will be announced during the lecture.

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Crop Genomics (Vorlesung mit integrierten Übungen, 4 SWS)
Ouzunova M, Mayer K, Haberer G, Kamal N, Würstl L, Teran Pineda M
For further information in this module, please click campus.tum.de or here.

Module Description

LS10001: Data Science in Agricultural Computer Science | Data Science in der Agrarinformatik

Version of module description: Gültig ab winterterm 2021/22

Module Level:	Language:	Duration:	Frequency:
Master	German	one semester	winter semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	90	60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung des Moduls wird in Form einer Projektarbeit erbracht. Die Projektarbeit umfasst ein Semesterprojekt (50%) sowie eine dazugehörige Präsentation der selbst gewählten Methodik (50%)
Das Semesterprojekt umfasst die eigenständige Entwicklung einer Datenpipeline sowie das Trainieren eines eigenen Prognosemodells. Abgegeben werden muss der programmierte Code sowie die dazugehörige Dokumentation (10 Seiten).
Die Problemstellung, der Datensatz, die Entwicklungsvoraussetzungen sowie die Benchmarkwerte des Semesterprojektes werden den Studierenden in der ersten Vorlesungseinheit vorgestellt.
Das Semesterprojekt muss dem Prüfer zum Prüfungstermin übermittelt werden und wird von diesem evaluiert.

Ausschlaggebend für die Benotung des Semesterprojektes ist die Performance des Modells auf einem definierten Testdatensatz sowie fehlerfreier Programmiercode. Die Note ergibt sich aus dem Erreichen der definierten Benchmarkwerte.

Freiwillige Prüfungsleistung:
Darüber hinaus besteht die Möglichkeit, eine freiwillige Studienleistung als Mid-Term gemäß APSO §6 Abs. 5 zu erbringen. Hierbei weisen die Studierenden in kleinen Programmier-, Datenauswertungs- und Matheaufgaben nach, dass die zugrundeliegende Methodik der Programmierung, statistischer Lernverfahren und Datenauswertung verstanden wurde. Sofern mindestens 2/3 der Mid-Term Aufgaben erfolgreich bearbeitet wurden, gilt die Mid-Term Leistung als erbracht. Diese Leistung ist freiwillig und hat auf das Bestehen der Prüfungsleistung keinen Einfluss. Das Bestehen der Mid-Term Studienleistung verbessert die Modulnote um 0,3. Für die Mid-Term Leistung wird kein Wiederholungstermin angeboten. Im Falle einer Wiederholungsprüfung wird eine bereits erbrachte Mid-Term Leistung berücksichtigt.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Mathematik 1, Statistik, Agrartechnik, Grundlagen Precision Farming

Content:
Das Modul besteht aus einer Vorlesung und einer Übung, die das Semesterprojekt thematisch begleiten.
Es werden folgende Themen behandelt:
• Grundlagen des Programmierens in Python
• Datenaufbereitung (Daten bereinigen, Daten Normalisieren)
• Datenvisualisierung (Verteilungen, Zeitreihen, Klassen)
• Grundlagen statistischer Lernverfahren (überwachtes und unüberwachtes Lernen, Regressions-/Klassifikationsmodelle, Clustering, Evaluation statistischer Modelle)

Das Semesterprojekt umfasst eine Programmierleistung in der Programmiersprache Python, die von jedem Studierenden individuell zu bearbeiten ist. Dieses umfasst:
• Automatisiertes auswerten eines großen landwirtschaftlichen Datensatzes
• Visualisieren der Daten und Extrahieren der wichtigsten Merkmale
• Erstellen einer eigenen Datenpipeline
• Entwickeln eines eigenen Vorhersagemodells

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage:

• Datenanalyse in der Programmiersprache Python anzuwenden
• Datenvisualisierung im richtigen Kontext durchzuführen
• Chancen und Risiken in der automatisierten Datenverarbeitung zu beurteilen
• Statistische Lernverfahren (Klassifikation, Regression) zu beurteilen und in Python anzuwenden
• Eine eigene Datenpipeline samt Prognosemodell in Python zu entwickeln

Teaching and Learning Methods:
Das Format besteht aus einer Vorlesung und einer inhaltlich begleitenden Übung. In Vorlesung werden die Prinzipien und die Methodik erläutert während die Übung praktische Programmierleistungen umfasst. Die Übung stellt zudem das Bindeglied zum Semesterprojekt dar. Durch das Semesterprojekt lernen die Studierenden die eigenständige Arbeit mit Daten in Python, indem sie technische, datengetriebene Lösungen zu landwirtschaftlichen Problemstellungen generieren.

Media:
Präsentationen, Programmierübung

Reading List:
• Trevor Hastie: The Elements of Statistical learning
• Rheinwerk Verlag: Python 3

Responsible for Module:
Asseng, Senthold; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

LS10039: Data Science for Agricultural Systems Analysis | Data Science for Agricultural Systems Analysis

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination of the module is carried out in the form of a project work. This consists of a brief technical report (word limit 2,500 words), and accompanying presentation (15 minutes; 10 minutes presentation plus 5 minutes discussion;(option for both in-class and zoom presentation). The report is submitted in combination with the data files (using Excel software), R script, and GIS (shape or raster) files (if any) used to conduct the analysis. The report and supplementary files (Excel, R script and GIS files) will be verified for consistency (i.e. so the data presented in the report reflects the analysis done in R & QGIS). The supplementary files will additionally be evaluated for clarity and correctness of methods (based on data management and R/GIS methods instructed through lectures(The supplementary data files do not count towards the 2,500-word length of the report). The final grade is derived 75% from the written report, with supplementary files accompanying the report, and 25% for the presentation.

The learning outcomes are examined by the student’s ability to choose an effective research hypothesis, analytic approach, and application of statistical concepts and software (R and GIS) relevant to the selected dataset and research objective. The report will be completed partly in class with instruction from supervisors and partly out of class and will be submitted 2 weeks from the last day of lectures/seminars.

The assessment is based on the criteria below:
• Ability to identify and apply statistical methods appropriate to data type and research objectives
• Ability to identify, interpret, and control confounding factors in analysis and experiment/survey data
• Ability to apply R and GIS software effectively to interpret data and convey results in report
• Ability to relate dataset and analytic method to a broader research objective of the student’s choice

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic experience handling datasets (Microsoft excel proficient)
Basic knowledge of R
Experience in any GIS software are useful but not required

Content:
1) Overview of select types of field-experimental or survey data relevant to agricultural and livestock systems analysis, including data collection methods
2) Data science: Theory and application of designs for field experiments and surveys
3) Data exploration and descriptive statistics for field-experiment and survey data, including measures of central tendency and dispersion and correlation coefficients (applied in R)
4) Parametric methods to evaluate field-experiment and survey data (applied in R), including basic regression techniques, analysis-of-variance (ANOVA), and treatment effects
5) Clustering methods to evaluate field-experiment and survey data (applied in R), including hierarchical and non-hierarchical clustering
6) Critical assessment of data-analytical methods for select scientific literature (specific to agricultural and livestock systems and comparable data-analytic methods)
7) Development of algorithms using the R software for handling survey and experiment datasets for agricultural and livestock systems
8) Application of GIS tools for the design and analysis of field-experiment/survey data
9) Critical appraisal of methods suitable to analyse agricultural and livestock systems
10) Techniques to effectively present results from the application of data analytics to agricultural systems

Intended Learning Outcomes:
Upon successful completion of this module, the students are able to:

• Understand key concepts involved in the design of field or survey experiments pertinent to given research objective(s)
• Understand and apply statistical methods for experimental and survey data analysis appropriate to a research objective(s)
• Discern appropriate analytical methods to answer questions related to experimental research
• Develop algorithms (R code) to analyse data and apply GIS tools to analyse field experiments and survey data
• Generate original research findings from existing datasets,
• Communicate findings through a project report, with accompanying presentation and supplementary data and script files

Teaching and Learning Methods:
• The module will be delivered through interactive lectures, integrated with exercises to assess theoretical and practical aspects of the module content

• The lectures are supplemented by seminars that will involve practical applications of R and GIS (using Quantum GIS, QGIS) to allow students to gain hands-on-experience in the tools required for the learning objectives and assignment
• Students will apply concepts learnt using a dataset of their choice, and conduct an analysis culminating in a presentation and a short report (word limit 2,500)
• The datasets provided will include at least one each of field experiment and survey based datasets
• Students interact with each other and the instructors both in the seminar room and online when working on their assignments.

Media:
Powerpoint slides, Moodle, Videos, Miro, Zoom.

Reading List:
Easterling, R.G. (2015). Fundamentals of Statistical Experimental Design and Analysis. Wiley. 246 pp.

Wickham, H., & Grolemund, G. (2023). R for Data Science. 2nd edition. O'Reilly. Sebastopol, USA. 520 pp.

Lumley, T. (2010). Complex surveys. A guide to Analysis Using R. Wiley. Hoboken, USA. 297 pp.

Bolstad, P. (2016). GIS Fundamentals. A first text on Geographic Information Systems. Fifth Edition. Acton, USA. 784 pp.

Responsible for Module:
Hawkins, James, Dr. james.hawkins@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Data science for agricultural systems (Vorlesung mit integrierten Übungen, 2 SWS)
Hawkins J

Analytic methods applied agricultural systems data (Seminar, 3 SWS)
Hawkins J, Sibilu H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1711: Development Policy and Economics: Human Security and Human Development | Development Policy and Economics: Human Security and Human Development

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
There will be a written examination (120 minutes, Klausur) were students demonstrate that they can:
(1) List the core principles of human security and development
(2) Evaluate the constraints to sustainable socio-economic development in developing countries based on inadequate policy formulation
(3) Understand particular development issues associated with fragile states in developing countries.
(4) Reproduce and interpret theoretical concepts relevant to development policy and economics, particularly with regard to human security and human development
(5) Match and apply the theoretical concepts of development policy and economics.

A written exam is an appropriate way to evaluate student´s understanding of existing theoretical and empirical scientific articles.

In addition, there is the possibility to perform a voluntary study performance as a mid-term performance according to APSO §6 (5). For this, a presentation (20 min) has to be passed. By passing the course work, the module grade is improved by 0.3, if, based on the overall impression, this better characterizes the student's performance level, and the deviation has no influence on the passing of the examination. No repeat date is offered for the mid-term performance. In the case of repeating the module examination, a mid-term performance already achieved will be considered.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor in agricultural economics, economics, development studies, political science or related fields.

Content:
While much of the world has made rapid progress in reducing poverty, improving collective security and attaining economic growth, regions characterized by repeated cycles of political and criminal violence are being left far behind, their economic growth compromised and their human development indicators stagnant.
Subsequently, this module has three main objectives. First, it introduces the students to key definitions and theoretical issues pertinent in theoretical development economics and policy.
The concepts of "human security" and "human development" of the United Nations are guiding principles here.
Second, the module discusses controversial issues related to human development, particularly with regard to using
national resources in a development orientated way. Third, whenever possible, current debates and policy reports are incorporated into the module, for instance the Sachs-Easterly debate on the "right approach" for development or the 2011 World Development Report of the World Bank on Conflict, Security and Development.

Intended Learning Outcomes:
Upon successful completion of this advanced module of development policy and economics, students are able to: (1) List the core principles of human security and development
(2) Evaluate the constraints to sustainable socio-economic development in developing countries using the Human Development Index (HDI) and ecological indicators
(3) Understand particular development issues associated with fragile states in developing countries.
(4) Reproduce and interpret theoretical concepts relevant to development policy and economics, particularly with regard to human security and human development
(5) Match and apply the theoretical concepts of development policy and economics.

Teaching and Learning Methods:
Lectures shall be on the basis of power point presentations to summarize the required theory and methodology. Supplementary reading material is distributed on a case by case basis. Moderated class discussions are used to establish a deeper understanding of current issues in development policy and economics. The seminar allows students to apply the knowledge acquired in class to case studies and evaluate the implication of certain policy options. A voluntary term paper shall also be part of the seminar. The structure and content of the term paper are pre-determined and groups of maximum three individuals are formed at the beginning of the semester. The group work shall be presented during classes were each group will have a time limit of 30 min (including discussion).

Media:
Power Point presentations will be used to summarize theories and methodologies. Blackboard illustrations will
supplement the course presentations.

Reading List:
Human development reports of the United Nations Development Program (UNDP).
Nafziger, E. W (2012): Economic Development. Cambridge University Press.
Banerjee, A.V., and E. Duflo (2011): Poor economics: A radical rethinking of the way to fight global poverty. New York; NY, USA: Public Affairs.

Responsible for Module:
Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

LS10016: Environment, Agriculture and Food | Environment, Agriculture and Food

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination of the module is carried out in the form of an individual report (4 pages, figures and tables in annex, word limit = 2,500), complemented by a presentation. The report and presentation account for 70% and 30% of the final grade, respectively.

The learning outcomes are examined with the explanation of key concepts. The report documents evidence of quantification of multiple selected metrics to assess livestock systems. The presentation is structured in slides and lasts no more than 20 min, followed by 10 min discussion, and will be scheduled within the lats three weeks of the semester. The report has to be handed in at the end of the semester.

The assessment is based on the criteria below:
• Ability to conceptualise multiple threats to the environment arising from agriculture and food systems by using quantitative metrics and other scientific evidence (theoretical thinking);
• Ability identify problems and propose solutions based on scientific evidence;
• Completeness and correctness of the evidence presented in the report;
• Presentation and demonstration of the material included in the assessment.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic nummercial skills to handle data and basic knowledge of R.

Content:
1) Agricultural and food systems, global, trends, dynamics and environmental threats;
2) The state of the environment in rural and urban food systems (in figures and maps);

3) Food systems, land use and climate change (theory, quantitative description and appraisal using the most recent literature);
4) GHG emissions, water and biodiversity (global goals and regional targets, assessment of progress);
5) Regional agricultural systems with important ecological, production and societal features;
6) Environment and development; synergies and tradeoffs with wellbeing.
7) Livelihoods and agricultural development in low and high-income countries;
8) Metrics to assess performance of agricultural and food systems (theory);
9) Application of metrics to assess local and regional agricultural and food systems (practical);
10) Critical assessment of future needs to balance environmental goals and economic growth.

Intended Learning Outcomes:
Upon completion of this module, the students will be able to:

• Identify key environmental issues arising from agricultural production and food systems.
• Appraise the scientific literature on current issues;
• Understand the economic and societal issues constraining the adoption of environmentally sustainable agriculture;
• Integrate theory, data and metrics to evaluate agricultural and food systems.
• Discuss solutions for environmental problems associated with agriculture and food;
• Write critically about environmental problems associated with modern agriculture identifying solutions;

Teaching and Learning Methods:
• The module will be delivered through lectures, integrated with interactive exercises to introduce theory, and guide the implemation of quantitative assessments.
• The module also includes a data handling training or refresher (2 weeks) to enable students to obtain and process (data mining) data from online open sources.
• Students learn how to apply concepts and methods and collaborate to solve practical problems, produce a report and communicate findings in class.
• Students interact with each other and the instructors both in the seminar room and online when working on their assigments.

Media:
Powerpoint slides, Moodle, Videos, Muro, Zoom etc.

Reading List:
FAO. 2022. The State of Food and Agriculture 2022. Leveraging automation in agriculture for transforming agrifood systems. Rome, FAO. https://doi.org/10.4060/cb9479en
Pörtner et al. 2023 Overcoming the coupled climate and biodiversity crises and their societal impacts. Science, 380, 256
Biesbroek et al. 2023 Toward healthy and sustainable diets for the 21st century: Importance of sociocultural and economic considerations. Proc National Academy Sci 120, 2219272120

Responsible for Module:
Rufino, Mariana, Prof. Dr. mariana.rufino@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Life Cycle Assesment applied to agricultural and food systems (Seminar, 1 SWS)
Hawkins J, Rufino M

Agriculture and food, trends, environmental challenges and solutions (Vorlesung mit integrierten Übungen, 2 SWS)
Rufino M

Quantifying environmental impacts of agriculture and food systems(multiple metrics) (Seminar, 1 SWS)
Rufino M
For further information in this module, please click campus.tum.de or here.

Module Description

LS10035: Experimental Methods in Ecophysiology | Experimental Methods in Ecophysiology

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is in the form of a laboratory report (15 to 20 pages).
The report introduces the topic, highlights the main methods in plant ecophysiology, summarizes the findings, and analyses of the measurements conducted during the module courses. Within the report, the students demonstrate that they understood how water flows in plants and soil and apply methods to monitor plant behavior during soil drying as well as showing the relationships between measured parameters and discuss the possible interpretations. The report should be submitted by the end of the semester.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in biophysical plant physiology (which is transferred, i.e., in participation in module LS20038).

Content:
The following topics are covered:
• Introduction to experimental methods in ecophysiology and biophysical plant physiology.
• Experimental methods assessing soil water status and hydraulic properties (TDR, HYPROP, TEROS 31, TEROS 21)
• Experimental methods measuring water fluxes from soil to plant (Sap-flow sensors, Isotopes [D2O])
• Plant water potential (matric potential, hydrostatic potential, osmotic potential)
• Methods assessing leaf water potential (Scholander pressure chamber, psychrometer, optical dendrometer, …)

• Experimentally measuring soil-plant hydraulics (root pressure chamber systems, rehydration kinetics)
• Methods evaluating plant responses to drying (stomatal regulation, turgor loss point, pressure volume curve)
• Experimental methods quantifying leaf gas exchange (transpiration rate, carbon assimilation rate) in response to soil drying
• Investigating root functional traits (root scanning and analysis, mycorrhiza colonization assessment)
• Imaging techniques in soil-plant interactions under drought (micro CT, Neutron radiography).
• Highlights on recent method advances and technical limitations on root-soil interaction

Intended Learning Outcomes:
After successfully completing the module, students are able to:
• Explain the principles of water flow in soil-plant-atmosphere continuum
• Differentiate processes/critically appraise linkages (e.g. classify the physical constraints on water flow in plant-soil system under different climatic and soil conditions)
• Understand and apply different methods to monitor plant behavior during soil drying, i.e., measure leaf water potential and leaf gas exchange during soil drying.
• Understand the principles of different methods to assess plant-soil interactions
• Measure water fluxes from soil to the plant using different methods (sap flow sensors), especially during soil drying.
• Design a set of experiments/models to test specific hypothesis (e.g. in regard to plant response to drought)
• Explore advanced techniques, including micro-computed tomography and neutron radiography, for imaging root-soil interaction under drought
• Evaluate and explain systematically the drivers of water stress to plants

Teaching and Learning Methods:
Oral presentations with PowerPoint presentations serving as visual aids, blackboard writing, discussion in class, and students’ presentations with discussions. The module consists of 2 SWS lectures with integrated exercises and 2 SWS practical sessions to provide a comprehensive learning experience and achieve the specified learning outcomes. The lectures are crucial for knowledge transfer and foundation building that are essential for understanding the biophysical processes of water movement across the soil-plant-atmosphere continuum. Practical sessions will offer opportunities for interactive learning and applications of the concepts in the field/lab. The combination of both types of courses encourages a holistic understanding of Experimental Methods of biophysical plant physiology.

Media:
Presentations via PowerPoint and blackboard writing. Group work at the Chair of Root-Soil Interaction, TDR, tensiometer, porometer, osmometer, Scholander pressure chamber

Reading List:
- Physicochemical and Environmental Plant Physiology, by: P. Nobel

- Suggested seminal research articles

Responsible for Module:
Ahmed, Mutez Ali Abdelrahman, Prof. Dr. rer. nat. mutez.ahmed@tum.de Abdalla, Mohanned, Dr. rer. nat. mohanned.abdalla@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Experimental methods in biophysical plant physiology (Vorlesung mit integrierten Übungen, 2 SWS)
Abdalla M, Ahmed M

Experimental methods in biophysical plant physiology practical (Praktikum, 2 SWS)
Ahmed M, Abdalla M
For further information in this module, please click campus.tum.de or here.

Module Description

LS20022: Experimental Methods in Soil and Plant Hydrology | Experimental Methods in Soil and Plant Hydrology

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is performed as a graded laboratory assignment. The grade for this module is determined by two factors. Firstly, the student's participation in conducting the planned experiments, collecting and analyzing data, and presenting the results to their peers, will contribute 40% towards the final grade. Secondly, students are expected to prepare an individual report, summarizing the findings of their analysis and measurements, which will make up 60% of the final grade. The report should be 10-20 pages in length and should be submitted by the end of semester.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Students interested in this module are recommended to visit first the lecture on Soil Biophysics (offered by the Professorship for Soil Biophysics and Environmental Systems) or any other equivalent lectures such as Introduction to Soil Science or Introduction to Soil Physics during their master and bachelor studies.

Content:
In this module, students will gain an understanding of how to experimentally quantify the physical and hydrological properties of soils and plants. Specifically, students will learn:
1. To assess basic soil physical properties such as soil texture, moisture, porosity, and density.
2. To determine the water retention and flow characteristics of various soils.
3. To investigate the infiltration and evaporation of water from different soils.
4. To evaluate plant responses to soil drying, such as transpiration rate, stomata conductance, and xylem leaf water potential.

5. To utilize various sensors and techniques to measure water content and water potential within soil and plant systems.

Intended Learning Outcomes:
Upon completion of the module, students will possess the ability:
1. To experimentally measure the physical and hydrological properties of soils.
2. To utilize advanced experimental methods and tools to quantify physical and hydrological properties of soils, including soil particle size distribution, soil retention curve, soil hydraulic conductivity curve, and water flow within soils and plants.
3. To experimentally compare the physical and hydrological properties of various soils.
4. To experimentally evaluate the response of plants to soil drying in various soils.

Teaching and Learning Methods:
This module is designed as a practical course, in which students will learn how to experimentally quantify the physical and hydrological properties of soils and plants. To achieve this, students will be divided into three groups. Two soil samples with contrasting textures will be selected, and each group will be assigned one sample. This means that there will be three replications of the two soil types, each managed by a different group.
In the first part of the practicum, students will be instructed in the quantification of soil physical properties that impact water retention and flow.
In the second part, students will grow plants in the two different soil textures and measure soil and plant water relations by determining the transpiration rate of the plants, the leaf water potential, soil water content, and soil water potential during soil drying cycles.

Media:
Whiteboard, PowerPoint, Lab work

Reading List:
1) Hillel, D. (1998). Environmental soil physics. San Diego (Calif.): Academic Press.
2) Soil Hydrology and Biophysics by John Selker & Dani Or (Open access book)
3) Weekly distributed lecture notes

Responsible for Module:
Zare, Mohsen, Prof. Dr. mohsen.zare@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced experimental methods in soil and plant hydrology (Übung, 4 SWS)
Zare M [L], Hafner B, Moser D, Zare M
For further information in this module, please click campus.tum.de or here.

Module Description

WI001204: Economics of Water Use, Regulation and Markets | Economics of Water Use, Regulation and Markets

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In a written examination at the end of the semester of 120 mins (in class), students will demonstrate the ability to understand and analyze concepts and methodological approaches related to water resource management using economic terminology, and the ability to apply mathematical tools to solve specific calculus problems. A written exam is necessary to assess the students' holistic understanding and analytical competencies.
In addition, there is the option of taking a voluntary mid-term assignment as coursework in accordance with APSO §6, 5. For this, an in-class presentation (~15 min) of a short research project related to water resource economics that they will choose from a list of references provided by the instructor has to be given. Students who are interested in participating in the research project activity will have to express their interest and choose a topic by the third week of the course. The module grade can be improved by 0.3 by passing the course work if this better characterizes the student's performance level on the basis of the overall impression and the deviation has no influence on passing the examination. No repeat date is offered for the mid-term performance. When retaking a failed module examination at the next possible examination date, successfully passed mid-term assignments will be taken into account.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students taking this course should be familiar with the basics of microeconomics as well as mathematical economics (derivatives, basic function integrals and graphs). However, all necessary concepts will be introduced before application.

Content:
The course will examine the incentives that lead to overexploitation of water recourses and how altering these incentives can promote socially optimal use patterns. The course will also provide the students with a set of analytical tools that can be used to work on water issues or natural resource issues more broadly.
Those topics are:
1. Introduction and Economics Basics
2. Agricultural Water Use
(water rights, agricultural water use efficiency and productivity, land allocation, technology choice, environmental quality)
3. Residential Water Use
4. Water, Land Use and Environmental Aspects of Biofuel Production
5. Other Approaches to Value Water
(hedonic modelling, experimental economics, nonmarket valuation approach)
6. Intertemporal and Interregional Aspects of Water
7. Water Markets Around the World
(Europe, China, USA)

Intended Learning Outcomes:
This course is designed to introduce students to the subject of water economics.
Upon successful completion of the module, students will be able to:
• understand the basic concepts and economic models used to study the economics of water resources issues.
• select and apply the appropriate economic model to solve water policy problems as for example producer’s profit or consumer’s utility maximization.
• provide economic intuition for mathematical answers to water management problems.
• apply models to address a wide range of water resource problems and assess the economic effects of decision making process at different levels based either on the water demand or the water supply side of the economy.
• critique journal articles pertaining to economics of water resources.

Teaching and Learning Methods:
Theoretical concepts and example exercises will be given by the lecturer on the blackboard and by PowerPoint presentations to build the required knowledge base in water resource economics. Q&A sessions at the beginning of each lecture will be provided to recapitulate the previous lecture. In addition, under the supervision and help of the lecturer, in-class application exercises will be used to create real-world water management problems for which students in randomly assigned groups will create and solve problems. Discussion of relevant scholarly articles and literature will be used to aid understanding of the topic covered.

Media:
Presentation slides, Blackboard, hand-outs, Moodle course to provide materials (pdf of papers to read)

Reading List:

Auffhammer, M. et al., “The Value of Supply Reliability in Urban Water Systems,” Journal of the Association of Environmental and Resource Economists, Working paper.
Caswell, M. & D. Zilberman, “The Effects of Well Depth and Land Quality on the Choice of Irrigation Technology,” American Journal of Agricultural Economics 68(1986): 798-811.
Chong, H. & D. Sunding, “Water Markets and Trading,” Annual Review of Environment and Resources 31(2006): 239-264.
Gisser, M., “Groundwater: Focusing on the Real Issue,” Journal of Political Economy 91(1983): 1004-1027.
Green, G. et al., “Explaining Irrigation Technology Choices: A Microparameter Approach,” American Journal of Agricultural Economics 78(1996): 1064-1072.
Renwick, M. & R. Green, “Do Residential Demand Side Policies Measure Up? An Analysis of Eight California Water Agencies,” Journal of Environmental Economics and Management 40(2000): 37-55.
Zilberman, D. et al., “Changes in Water Allocation Mechanisms for California Agriculture,” Contemporary Economic Policy 12(1994): 122-133.

The list will be expanded and updated using material from a variety of textbooks and journal papers corresponding to each of the topics.

Responsible for Module:

Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0035: Nutrition Concepts for Farm Animals | Ernährungskonzepte für Nutztiere

Version of module description: Gültig ab summerterm 2022

Module Level:	Language:	Duration:	Frequency:
Master	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	90	60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer individuellen, 25-30 minütigen mündlichen Prüfung erbracht. In dieser wird abgefragt, inwieweit die Prinzipien und ernährungsphysiologischen Konsequenzen der verschiedenen wissenschaftlichen Nährstoffkonzepte verstanden worden sind. Der Studierende soll die vorgestellten Konzepte auf konkrete Fallbeispiele für Monogaster und Wiederkäuer anwenden, ihre Vorzüge und Limitierungen darlegen und hinsichtlich ihrer Umweltrelevanz bewerten können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreicher Abschluss des Bachelorstudiengangs Agrar- und Gartenbauwissenschaften (agrarwissenschaftliche Orientierung) der TUM oder äquivalenter Abschluss.

Content:
Wissenschaftlich wird in der Fütterung von landwirtschaftlichen Nutztieren ebenso wie in der Futterbewertung meist mit "Nährstoffkonzepten" gearbeitet. Deren Hintergründe werden in vorliegendem Modul eruiert und in ihren Konsequenzen für die Bestimmung von Nährstoffbedarf und bedarfsgerechter Nährstoffversorgung von Monogaster und Wiederkäuer diskutiert. Dabei werden auch Stoffströme und umweltrelevante Emissionen mit berücksichtigt.
Themen:
- Wiederkäuer:
- Nettoenergie Laktation
- Nutzbares Protein am Duodenum
- pansenstabile Futterinhaltsstoffe (z.B. Stärke, Vitamine,
Mineralstoffe)

- Strukturwert
- Monogaster:
- Umsetzbare oder Nettoenergie beim Schwein?
- präzäkal verdauliches Protein (Aminosäuren)
- Futterstruktur
- verfügbare Mineralstoffe

Intended Learning Outcomes:
Durch die Teilnahme an den Lehrveranstaltungen erwerben die Studierenden ein tiefgehendes Verständnis für die einzelnen bei landwirtschaftlichen Nutztieren angewandten Nährstoffkonzepte. Sie sind in der Lage, unterschiedliche Versorgungssituationen zu bewerten und Strategien zur bedarfsdeckenden, leistungsorientierten Nährstoffversorgung zu entwickeln. Stoffströme von der Aufnahme bis hin zu umweltrelevanten Emissionen können quantifiziert und optimiert werden.

Teaching and Learning Methods:
Das Modul gliedert sich in zwei getrennte Abschnitte, um die speziellen Aspekte monogastrischer (wie bei Schwein und Huhn) und polygastrischer Verdauungssysteme (wie beim Wiederkäuer) betrachten zu können. In präsentationsgestützten Vorlesungen, die ggf. auch online per Livestream abgehalten werden können, werden jeweils die in der modernen Wissenschaft angewandten Nährstoffkonzepte vorgestellt und in einer vertiefenden Diskussion mit den Studierenden kritisch untersucht.

Media:
PowerPoint-Präsentation; Skriptum; ggf. online per Livestream und/oder Lehrvideos

Reading List:
Gesellschaft für Ernährungsphysiologie: Ausschuss für Bedarfsnormen, 1995, 2000, 2001, 2006

Responsible for Module:
Prof. Steinhoff-Wagner

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0041: Economics of Technology and Innovation | Economics of Technology and Innovation

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
There will be a written exam (Klausur) of 120 minutes at the end of the semester. The students will be asked to demonstrate their ability to understand and analyze concepts and methodological approaches of the economics of technology and innovation using conceptual frameworks and methods currently used in the field. A written exam is necessary in order to assess the holistic understanding and analytical competencies of the students.

The students are requested to demonstrate that they understand the implications of innovation adoption (e.g. the potential effect of an innovation for non-adopters), can distinguish between the effects of various constraints and incentives on adoption (e.g. profitability and access to credit), and are aware of commonly known methodological pitfalls (e.g. omitted variable bias, reverse causality). In addition, the student will have the ability to create their own research designs on specific case studies provided by the instructors.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics of microeconomics, statistics, econometrics

Content:
This course covers the determinants of technology adoption and innovations and their effects on economic, environmental, and social outcomes.

The course consists of lectures and seminar activities. The lectures are devided in six blocks:
1) Role and Relevance of Innovation and Technology
2) Theoretical Models on the Economics of Innovation and Technology

3) Empirical Models on the Economics of Agricultural Innovation and Technology
a) Matching and classification
b) Regression Discontinuity Design
c) Instrumental Variables
d) Difference-in-Differences
e) Synthetic Control
4) Seminal Articles
5) Recent Trends
6) Open Questions and Presentations
In the seminar the students present specific technological and economic articles followed by discussions.

Intended Learning Outcomes:
After successful completion of the course, the students will be able to:
(1) apprehend the basic concepts of technology and its role on the economic development,
(2) understand the socio-economic effects and relevance of agricultural innovations,
(3) explore the reasons why innovations usually do not instantly and fully diffuse,
(4) select and apply the appropriate economic methods used to understand points (1) and (2),
(5) critique journal articles pertaining to economics of technology innovation and adoption, especially regarding research methodology and topics (e.g. experiments investigating behavioral biases, estimation of profit heterogeneity).
(6) examine whether a research design is able to identify the effects and / or adoption determinants of an agricultural technology
(7) provide hands-on practice to implement these research designs
(8) identify what kind of research would make a significant contribution to the field of innovation economics..

Teaching and Learning Methods:
Half the course (2SWS) consists of lectures, the other half (2SWS) consists of student presentations and discussions. In the Lecture part of the course, theoretical concepts and practice exercises will be given by the lecturers on the blackboard and by PowerPoint presentations to build the required knowledge base in innovation and technology economics. In addition, under the supervision and help of the lecturer, in-class application exercises will be used to create real-world problems for which students in randomly assigned groups will create and solve problems. Discussion of relevant scholarly articles and literature will be used to aid understanding of the topic covered. The lectures will promote the basics and the seminar will build upon this. This encourages the students to independently and self-reliantly study the literature guided by a structured framework. In the Seminar part of the course, Students will give an in-class presentation (~15 min) of a paper related to innovation and technology economics that they will choose from a list of references provided by the instructor.

Media:
Presentation slides, Blackboard, hand-outs, Moodle course to provide materials (pdf of papers to read)

Reading List:
Angrist, J.D. and J.-S. Pischke Mastering'metrics: The path from cause to effect, Princeton University Press, 2014). Carter, M.R. "What farmers want: The “gustibus multiplier” and other behavioral insights on agricultural development." Agricultural Economics, Vol. 47, (2016) pp. 85-96.
Conley, T.G. and C.R. Udry "Learning about a new technology: Pineapple in ghana." The American Economic Review, (2010) pp. 35-69.
Duflo, E., M. Kremer and J. Robinson "Nudging farmers to use fertilizer: Theory and experimental evidence from kenya." The American Economic Review, Vol. 101, (2011) pp. 2350-2390.
Feder, G., R.E. Just and D. Zilberman "Adoption of agricultural innovations in developing countries: A survey." Economic development and cultural change, (1985) pp. 255-298.
Foster, A.D. and M.R. Rosenzweig "Microeconomics of technology adoption." Annual Review of Economics, Vol. 2, (2010).
Griliches, Z. "Hybrid corn: An exploration in the economics of technological change." Econometrica, Journal of the Econometric Society, (1957) pp. 501-522.
Karlan, D., R. Osei, I. Osei-Akoto and C. Udry "Agricultural decisions after relaxing credit and risk constraints*." Quarterly journal of economics, Vol. 129, (2014).
Sauer, J. and D. Zilberman "Sequential technology implementation, network externalities, and risk: The case of automatic milking systems." Agricultural Economics, Vol. 43, (2012) pp. 233-252.
Self, S. and R. Grabowski "Economic development and the role of agricultural technology." Agricultural Economics, Vol. 36, (2007) pp. 395-404.
Sunding, D. and D. Zilberman "The agricultural innovation process: Research and technology adoption in a changing agricultural sector." Handbook of agricultural economics, Vol. 1, (2001) pp. 207-261.
Suri, T. "Selection and comparative advantage in technology adoption." Econometrica, Vol. 79, (2011) pp. 159-209.
Vrachioli, M., Stefanou, S.E. and Tzouvelekas, V. “Impact Evaluation of Alternative Irrigation Technology in Crete: Correcting for Selectivity Bias.” Environ Resource Econ, Vol. 79, (2021) pp. 551–574. https://doi.org/10.1007/s10640-021-00572-y
Wuepper, D. and T. Lybbert "Perceived self-efficacy, poverty, and economic development." Annual Review of Resource Economics, Vol. 9, (2017).
Wuepper, D., J. Sauer and L. Kleemann "Sustainable intensification amongst ghana’s pineapple farmers: The complexity of an innovation determines the effectiveness of its training", Environment and Development Economics: Online First, 2017).

The list will be expanded and updated using material from a variety of textbooks and journal papers corresponding to each of the topics.

Responsible for Module:
Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0048: Experimental Desigs for Animal Nutrition and Nutrition Physiology | Experimentelle Modelle in der Tierernährung und Ernährungsphysiologie

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer individuellen, 25-30 minütigen mündlichen Prüfung erbracht. In dieser wird abgefragt, inwieweit die verschiedenen experimentellen Modelle zur Durchführung von wissenschaftlichen Ernährungsversuchen an landwirtschaftlichen Nutztieren und die dazugehörigen Auswertungsmethoden charakterisiert werden können. Anhand einer konkreten Fragestellung muss ein Versuchsplan entworfen werden, bei dem Versuchsparameter, Versuchsmodell und Auswertungsmethode richtig aufeinander abgestimmt werden müssen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreicher Abschluss des Bachelorstudiengangs Agrar- und Gartenbauwissenschaften (agrarwissenschaftliche Orientierung) der TUM oder äquivalenter Abschluss im Bereich der Biologie.

Content:
Für aktuelle Themen der Ernährungsphysiologie landwirtschaftlicher Nutztiere und der internationalen Tierernährungsforschung werden anhand von Fallbeispielen konkrete Versuchsmodelle erarbeitet, die auf die Beantwortung der jeweiligen Fragen ausgerichtet sind.
- Verdauungsversuch
- Stoffwechselversuch
- Dosis-Wirkungsversuch
- Transferversuche
- Versuche unter Verwendung von Isotopen
- Alternativen zum Tierversuch

- Herstellung hochpräzise zusammengesetzter Futtermischungen
- Haltung der Versuchstiere im Rahmen gesetzlicher Haltungsvorschriften
- Auswahl und Erfassung geeigneter Versuchsparameter
- Kriterien zuverlässiger Probenahme und -aufbereitung
- Datenauswertung mit verschiedenen statistischen Methoden (Varianzanalyse, Broken-line-Model und Varianten, Regressionsanalyse etc.)

Intended Learning Outcomes:
Die Studierenden können nach Teilnahme an diesem Modul verschiedene experimentelle Modelle zur Durchführung von wissenschaftlichen Ernährungsversuchen an landwirtschaftlichen Nutztieren charakterisieren. Sie können unterscheiden, bei welchen Fragestellungen welches Modell idealerweise angewendet werden muss und können die für diesen Fall richtige statistische Auswertungsmethodik ermitteln. Sie stimmen Versuchsparameter, Versuchsmodell und Auswertungsmethode richtig aufeinander ab. Sie können Fütterungsversuche mit unterschiedlichen Zielsetzungen planen und dabei sowohl die Bedeutung von Einflussfaktoren und Statistik einschätzen als auch die Ergebnisse kritisch beurteilen.
Aufgrund der umfassenden Kenntnisse, die in diesem Modul für die Planung und Auswertung von Fütterungsversuchen verschiedenster Art vermittelt werden, ist es insbesondere für solche Studierende zu empfehlen, die eine Masterarbeit oder eine spätere Tätigkeit im Forschungsbereich Tierernährung anstreben.

Teaching and Learning Methods:
Das Modul ist als Seminar geplant, in dem verschiedene in der modernen Tierernährungsforschung angewandten Versuchsmodelle zunächst präsentationsgestützt beschrieben und erklärt werden. Dabei wird nicht nur auf die verschiedenen Versuchsansätze, sondern auch auf ergebnisbeeinflussende Faktoren (Umwelt, Haltung, Versuchstierauswahl etc.) und relevante Versuchsparameter sowie statistische Auswertungsmethoden eingegangen. Gemeinsam wird dann in Gruppenarbeit für konkrete Fragestellungen das geeignete Versuchsmodell ausgewählt und ein exakter Versuchsplan erstellt. Anhand von Daten aus Fallbeispielen wird schließlich eine statistische Auswertung der Ergebnisse durchgeführt.

Media:
PowerPoint-Präsentation; Hand-outs von Fallbeispielen

Reading List:
Auf relevante Veröffentlichungen wird jeweils am Ende der Präsentationen verwiesen

Responsible for Module:
Steinhoff-Wagner, Julia; Prof. Dr.sc.agr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ4032: Entomology | Entomologie

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module is completed with a report. In it, students should demonstrate that they know the most important insect groups and their ecological role, know about their biology and can apply this knowledge to concrete entomological questions on the interactions of plants and insects in the context of a scientific experiment. Learned knowledge should be reproduced in a structured way and the research question should be analyzed scientifically. The report should demonstrate that the essential aspects have been grasped and can be reproduced in written form. The report comprises 15-20 pages and is structured like a publication, i.e. it includes an abstract, introduction, materials and methods used, results and a concluding discussion as well as a list of references used.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of Zoology, Ecology and Physiology is mandatory

Content:
The module covers the (chemical) ecology, behavior, diversity and evolution of important insect groups, their species-specific resource use, their natural counterparts as well as theories on ecosystem processes/functions and services. Furthermore, based on chemical ecology, the basics of biological control of insect pests are presented as well as the possibilities of their practical application.

Intended Learning Outcomes:
After successful participation in the module course, students know important insect groups and their role in natural and human-influenced ecosystems. They are able to deduce and evaluate their impact on plants (including crops) and ecosystem processes based on ecology, behavior, diversity,

evolution and ecosystem function. This competence allows them to assess their role in ecosystems also under the influence of global change and alternative land use. In addition, they understand the most important ecological and physiological principles of biological control.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. In the lecture, the necessary knowledge is imparted by the lecturers in the form of lectures and presentations and discussed together with the students. The students are encouraged to deal with the content of the topic and to study the scientific literature as well as the lecture notes. In the exercises, important insect groups are observed, determined and their behavior as well as resource use are studied within the framework of an experiment in small groups.

Media:
Power Point presentation, on-site demonstration, documentaries, pictures and collection material

Reading List:
Miller und Miller, Insect-Plant Interactions, Springer; Chinery, Insects of Britain and Western Europe, A&C Black; Gullan, The Insects: An Outline of Entomology

Responsible for Module:
Leonhardt, Sara Diana; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WI000948: Food Economics | Food Economics

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Students prove their achievement of learning outcomes in an oral exam of 25 minutes. The exam is designed to test whether students understand the discussed topics and publications, whether they can describe and explain them in a meaningful and exact way, and whether they can critically reflect on assumptions, methodology, results, and political and societal implications of research in food economics. An oral exam is the most suitable format to account for the discursive and reflective nature of the abilities examined.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The course applies microeconomic theory to study questions of food demand and supply. Students should feel comfortable with the material in microeconomic courses at introductory level.

Content:
The course is intended to provide students with in-depth coverage of food economics with an emphasis on trends and phenomena of food markets and value chains, food labelling, food safety, food consumption, nutrition and food policy. Taking examples from these domains the course introduces a variety of economic models that are being used in food-economic research.

Intended Learning Outcomes:
At the end of the module, the students are able to (1) outline important trends and phenomena in food markets in Germany, Europe and the world, (2) analyse consumer and firm behavior in food markets based on economic theory, (3) assess the effectiveness of food policy instruments, (4) acquaint themselves with scientific literature in the area of food economics and discuss and evaluate crucial assumptions, choice of methodology and implications of results.

Teaching and Learning Methods:
The module is designed as an interactive lecture where both lecturers and students provide input for discussion. In order to set up a common basis for participants, lecturers present information on major features and trends on food markets and economic concepts used to analyze them. To familiarize themselves with economic research, students read selected journal articles from the field of agricultural and food economics and prepare a short presentation of 15 minutes and a short report of about 2 pages once per semester, summarising the main hypotheses, methods applied, results obtained and implications derived. Subsequent discussions in classroom on assumptions, limitations of data and methods, as well as on different ways to interprete results deepen students' understanding of the potential and restrictions of research in food economics.

Media:
Slides, textbooks, journal articles, blackboard, collection of summaries of publications.

Reading List:
Lusk, J. L., Roosen, J, & Shogren, J. F. (eds.) (2011). The Oxford handbook of the economics of food consumption and policy. Oxford University Press: New York.
Additional references are provided in the course.

Responsible for Module:
Roosen, Jutta; Prof. Dr. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Food Economics (WI000948, englisch) (Vorlesung, 4 SWS)
Roosen J, Menapace L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0049: Functional Feed Science | Funktionelle Futtermittelkunde

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer individuellen, 25-30 minütigen mündlichen Prüfung erbracht. In dieser wird geprüft, inwieweit Futtermittelrecht, Futtermittelsicherheit und Sicherung von Futtermittel- und Produktqualität charakterisiert werden können. Desweiteren müssen Futterzusatzstoffe und antinutritive Futterinhaltsstoffe unterschieden und deren Bedeutung für die Fütterung und den Stoffwechsel des Nutztieres eingeschätzt werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreicher Abschluss des Bachelorstudiengangs Agrar- und Gartenbauwissenschaften (agrarwissenschaftliche Orientierung) der TUM oder äquivalenter Abschluss. Der vorherige Besuch der Module "Futtermittelkunde und Rationsgestaltung" und "Futtermittelanalytik" im Zuge des Bachelorstudiums wird empfohlen.

Content:
Der Inhalt des Modul umfasst hauptsäuchlich folgende Aspekte:
- Futtermittelrecht
- Futtermittelsicherheit
- Qualitätssicherung
- Futterzusatzstoffe
- Diätfutter - Bedeutung und Einsatz
- Antinutritive Inhaltsstoffe und ihre Wirkungen
- Sonstige funktionelle Wirkungen von Futterinhaltsstoffen auf
- Enzyme
- Hormone
- Bakterien

Intended Learning Outcomes:
Nach erfolgreichem Abschluss des Moduls können die Studierenden die Regeln des Futtermittelgesetzes im Hinblick auf Futtermittelsicherheit und Qualitätssicherung bei der Erstellung von Futtermischungen anwenden. Sie charakterisieren die Einsatzbereiche der verschiedenen Futterzusatzstoffe und unterscheiden deren Wirkung in Verdauungstrakt und Stoffwechsel. Der Effekt antinutritiver Futterinhaltsstoffe auf physiologische Parameter kann bewerten werden. Sie sind in der Lage unterschiedliche Methoden und Konzepte der Risikoanalyse anzuwenden und anhand von Beispielen präventive Strategien zu erläutern.

Teaching and Learning Methods:
ie Vermittlung des Modulinhalts erfolgt in Form einer präsentationsgestützten Vorlesung. Im lehrstuhleigenen Futtermischlabor werden Aspekte zu Futtermittelsicherheit und Futtermittelrecht (z.B. Verschleppung, Mischgenauigkeit) praktisch untersucht. Fachspezifische Fälle aus der Vergangenheit werden durch jeden einzelnen Studierenden anhand wissenschaftlicher Publikationen und Medienrecherchen erarbeitet, als Kurzreferat präsentiert und in Seminarform diskutiert.

Media:
PowerPoint Präsentationen, Skript

Reading List:

Responsible for Module:
Steinhoff-Wagner, Julia; Prof. Dr.sc.agr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1415: Research Project: Behavioral Physiology of Plant-insect Interactions | Forschungspraktikum zu verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 240	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is a laboratory assignment, i.e. students are required to work on one or more research questions largely independently. In some cases, predefined protocols are available for implementation. The students carry out some field work as well as laboratory work and are instructed in the working methods and equipment so that they can use the methods mostly completely independently, in some special cases under supervision. As part of the research internship, they collect data, which they analyze and present. They are expected to relate the results obtained to the questions and hypotheses they have developed and place them in a broader scientific context.

Following the internship, the skills gained are assessed in writing in the form of a graded report that meets scientific standards and must be submitted within 4-6 weeks of completing the internship. This is a written paper of 20-50 pages, which should first introduce the topic to be worked on by listing previously published scientific papers, explain the research questions and hypotheses, then list the methods used (including statistics) in detail, present all results and finally discuss them in relation to existing literature. With the protocol, the students prove that they can successfully work on a thematically limited but challenging question of insect-plant interaction with a focus on the associated behavioral-physiological principles within a limited time and present and conclude it according to scientific conventions. In order to test the necessary ability to communicate the results and to examine related topics that are not a core component of the protocol, a presentation (20 min) must be given within the working group as part of the laboratory work and after completion of data acquisition and evaluation. It is recommended that the presentation be given 2-3 weeks before the submission of the protocol.

The performance of the protocol and presentation will be assessed with one grade, whereby the protocol has approximately twice as much weight as the presentation.

The contact time with the supervisor is approximately 60 hours. The remaining 240 hours consist of independent work in the field, laboratory, and library. Of these, around 40 hours are spent on the preparation of the protocol and the presentation.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge of ecology, botany and/or entomology is required, for example at the level of the modules "General Ecology", "Basic Course/General Botany" and/or "Basic Course/General Zoology". Depending on the final project topic, basic knowledge of biodiversity, nutritional ecology, physiology or neurobiology is desirable, for example at the level of the lectures/seminars "Diversity and Evolution of Ferns and Seed Plants", "Vegetation of the Earth", "Function and Interaction of Insects in Forest Ecosystems", "Bee Science", "Cognitive Neuroscience" or "Sensory Physiology".

Content:
Within this research internship, topics from the field of insect ecology can be dealt with. Examples would be the topics "Influence of pesticides on the learning and foraging behavior of bees" or "Nutrient perception in different bee species"; this usually involves a combination of behavioral experiments and field or cage observations. Furthermore, behavioral experiments can also be combined with chemical analyses (e.g. GCMS). Experiments with other insects (butterflies, flies, beetles, ants) are also possible. The focus in this research module is on the study of the physiology of behavior underlying interactions between certain insect species and certain plant species. As far as possible, students will carry out and evaluate the experiments independently. The exact topic is to be agreed with the respective lecturer.

Intended Learning Outcomes:
After successfully completing the module, students will be able to carry out experiments on the behavioral-physiological interactions between plants and insects as well as their evaluation largely or completely independently. This includes the design of field experiments, the systematic recording of data in the field, the conditioning of bees using existing laboratory protocols and the statistical analysis of experimental results with the help of the open software program R. In addition, they learn the ability to write in a scientifically structured format and to relate their results to the questions posed and hypotheses they have developed and to place them in a broader scientific context.

Teaching and Learning Methods:
Teaching method: Discussion, instruction on special equipment, e.g. micromanipulators, until independent work is possible; instruction on work in the field until independent field work can be carried out; discussion of interim results in the chair seminar; if necessary, instruction on the preparation of a scientific paper.
Learning method: work in the field and laboratory; systematic data collection and evaluation; graphical presentation of results, writing and presentation; study of literature and basic textbooks.

Media:
Instructions for field work and laboratory experiments, protocols for conditioning and evaluations, working group seminars and discussions, oral statistical introduction, R scripts, scientific literature, books, databases

Reading List:
Scientific literature is handed out during the practical course and should also be compiled in independent literature research.
Example of a standard work on the topic:
Nickolas M. Waser & Jeff Ollerton (2006): Plant-Pollinator Interactions: From Specialization to Generalization
Stephen J. Simpson & David Raubenheimer (2012) The Nature of Nutrition

Responsible for Module:
Leonhardt, Sara Diana; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum zu verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten (Praktikum, 10 SWS)
Leonhardt S [L], Leonhardt S, Nebauer C, Prucker P, Rüdenauer F, Werle S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1416: Research Project: Chemistry of Plant-Insect Interactions | Forschungspraktikum zu chemischen Interaktionen zwischen Pflanzen und Insekten

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 240	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is a laboratory course, i.e. students are expected to work on one or more research questions largely independently. Some of the protocols for carrying out the work are provided. The students carry out some field work as well as laboratory work and are instructed in the working methods and equipment so that they can usually use the methods completely independently, in some special cases under supervision (e.g. a gas chromatograph coupled to a mass spectrometer, GCMS). As part of the research internship, sis collect data, which they analyze and present. They are expected to relate the results obtained to the questions and hypotheses they have developed and place them in a broader scientific context.

Following the internship, the skills gained are assessed in writing in the form of a graded report that meets scientific standards and must be submitted within 4-6 weeks of completing the internship. This is a written paper of 20-50 pages, which should first introduce the topic to be worked on by listing previously published scientific papers, explain the research questions and hypotheses, then list the methods used (including statistics) in detail, present all results and finally discuss them in relation to existing literature. With the protocol, the students prove that they can successfully work on a thematically limited but challenging question of insect-plant interaction with a focus on the associated chemical processes within a limited time and that they can present and conclude it according to scientific conventions. In order to also test the necessary ability to communicate the results and to check related topics that are not a core component of the protocol, a lecture (20 min) must be given within the working group as part of the laboratory work and after completion of data acquisition and evaluation. It is recommended that the presentation be given 2-3 weeks before submission of the protocol.

The performance of the protocol and presentation will be assessed with one grade, whereby the protocol has about twice as much weight as the presentation.

The contact time with the supervisor is approximately 60 hours. The remaining 240 hours consist of independent work in the field, laboratory and library. Of these, around 40 hours are spent on the preparation of the protocol and the presentation.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge of ecology, botany and/or entomology is required, for example at the level of the modules "General Ecology", "Basic Course/General Botany" and/or "Basic Course/General Zoology". Depending on the final project topic, basic knowledge of biodiversity, nutritional ecology, physiology or neurobiology is desirable, for example at the level of the lectures/seminars "Diversity and Evolution of Ferns and Seed Plants", "Vegetation of the Earth", "Function and Interaction of Insects in Forest Ecosystems", "Bee Science", "Cognitive Neuroscience" or "Sensory Physiology".

Content:
Within this research internship, topics from the field of insect ecology can be dealt with in both temperate and tropical ecosystems. Examples would be the topics "Influence of pollen nutrition quality on the foraging behavior of honey bees" or "Importance of plant resins for social bees"; this usually involves a combination of chemical analyses and field or cage observations. Experiments can also be carried out with other insects (butterflies, flies, beetles, ants). The emphasis in this research module is on the study of the chemistry underlying interactions between certain insect species and certain plant species. As far as possible, students will carry out and evaluate the experiments independently. The exact topic is to be agreed with the respective lecturer.

Intended Learning Outcomes:
After successfully completing the module, students will be able to carry out experiments on the chemical interactions between plants and insects and evaluate them largely or completely independently. This includes the design of field experiments, systematic data acquisition and sampling in the field, the extraction and chemical analysis of samples using gas chromatography mass spectrometry (GCMS) based on existing laboratory protocols, the chemical analysis of samples using the Chemstation program, and the statistical analysis of experimental results using the open software program R. In addition, they learn the ability to write in a scientifically structured format and to relate their results to the questions they have received and the hypotheses they have developed themselves, as well as to place them in a broader scientific context.

Teaching and Learning Methods:
Teaching method: discussion, instruction on special equipment, e.g. GCMS, rotary evaporator, Soxhlet apparatus, until independent work is possible; instruction on work in the field until independent field work can be carried out; discussion of interim results in the chair seminar; if necessary, instruction on the preparation of a scientific paper.
Learning method: work in the field and laboratory; systematic data collection and evaluation; graphical presentation of results, writing and presentation; study of literature and basic textbooks.

Media:
Instructions for field work and laboratory experiments, protocols for chemical analyses and evaluations, working group seminars and discussions, oral statistical introduction, R scripts, scientific literature, books, databases

Reading List:
Scientific literature is handed out during the practical course and should also be compiled in independent literature research.
Example of a standard work on the topic:
Nickolas M. Waser & Jeff Ollerton (2006): Plant-Pollinator Interactions: From Specialization to Generalization

Responsible for Module:
Leonhardt, Sara Diana; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum zu chemischen Interaktionen zwischen Pflanzen und Insekten (Praktikum, 10 SWS)
Leonhardt S [L], Leonhardt S, Nebauer C, Prucker P, Rüdenauer F, Werle S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1470: Feed Stuff Conservation and Feed Quality | Futterkonservierung und Futterqualität

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 120.
Die Modulprüfung wird in Form einer Klausur erbracht. In dieser sollen Kenntnisse über verfahrenstechnische Maßnahmen im Rahmen der Grünfuttergewinnung und -konservierung nachgewiesen werden. Außerdem sollen die Studierenden zeigen, dass sie Fragen zu den Nährstoffgehalten und deren Variabilität von Grob- und Konzentratfuttermitteln beantworten können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
1) Kenntnisse zum Pflanzenbau (Grünlandbewirtschaftung, Ackerfutterbau) sowie Grundlagen der Tierernährung (SG B.Sc.)
2) Erfolgreich absolvierte Module aus dem vorliegenden Master-SG: Ackerfutterbau, Graslandagronomie und Ökologie

Content:
In diesem Modul sollen insbesondere folgende fachliche und methodische Inhalte vermittelt werden:
- Konservierungsmöglichkeiten und -verfahren für Futtermittel in der Nutztierfütterung
- Grobfuttermittel: Futterwert bestimmende Eigenschaften, Einsatzmöglichkeiten und -grenzen in der Nutztierfütterung;
- verfahrenstechnische Maßnahmen bei der Werbung von Grünfuttersilagen
- Handelsfuttermittel: Gewinnung, Futterwert bestimmende Eigenschaften, rechtliche Rahmenbedingungen sowie Einsatz in der Nutztierfütterung
- Schätzung des Energiegehaltes von Futtermitteln

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme an diesem Modul sind die Studierenden in der Lage
- relevante Verfahrenstechniken bei der Werbung von Grünfuttersilagen anzuwenden
- verschiedene Konservierungsverfahren für Grünfutter zu verstehen
- qualitätsbestimmende Kriterien von Grünfutterkonserven zu analysieren
- die Futterwert bestimmenden Eigenschaften von wichtigen Handelsfuttermitteln einzuschätzen und daraus den sachgerechten Einsatz in der Nutztierfütterung zu ermitteln
- verschiedene Methoden zur Schätzung des Energiegehaltes von Futtermitteln anzuwenden

Teaching and Learning Methods:
Vortrag: Vermittlung von reproduzierbaren Inhalten;
Gruppenarbeit: kritische Beurteilung von Methoden; Experiment: Übung technischer Fertigkeiten

Media:
PowerPoint-Präsentation, Skripten, Fallbeschreibungen, moodle-Kurs

Reading List:
Jeroch u.a. (Hrsg.): Futtermittelkunde;
Kling u. Wöhlbier (Hrsg.): Handelsfuttermittel

Responsible for Module:
Brigitte Dr. Paulicks (paulicks@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ4189: Fisheries and Aquatic Conservation | Fisheries and Aquatic Conservation

Version of module description: Gültig ab summerterm 2024

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	90	60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a 60 min. written exam (Klausur). In addition, the students need to prepare a 10-15 min. presentation in the practical exercise. Gradings from the examination and the presentation are weighed in the ratio 2:1. The examination means to measure the student's ability to assess anthropogenic influence on aquatic ecosystem functioning, evaluate the socioeconomic importance of fisheries and aquaculture, explain factors affecting susceptibility to and recovery from overexpoitation, create and apply sustainable aquatic conservation tools and recall fisheries management tools for wild populations as well as of the underlying biological principles such as fish population dynamics. In the written examination students demonstrate by answering questions under time pressure and without helping material their theoretical and practical (e.g. application of methods) knowledge about fisheries management. For answering the questions, the students require their own wording. In the practical exercise the students prepare a presentation in form of a brochure, poster, video or podcast. For the presentation, the student is expected to demonstrate that he or she is capable of preparing a certain topic within a given time frame in such a way as to present or report it in a clear and comprehensible manner to specific target audiences in the context of fisheries and aquatic conservation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Interest in aquatic biology, social sciences, conservation biology and management; this course can be selected independently from other courses in the fields of Fish Biology and Limnology at TUM

Content:
The module combines the theoretical background and the practical implementation of fisheries management and aquatic conservation. The key aspects are:

1. Introduction to fish, shellfish and fisheries management,
2. The socioeconomic importance of fisheries and aquaculture,
3. The functioning of aquatic ecosystems and the impacts of fisheries on aquatic ecosystem health,
4. Factors affecting susceptibility to and recovery from overexploitation,
5. Fisheries Management Tools for wild populations,
6. Aquaculture,
7. Aquatic Biodiversity Conservation,
8. Case study and knowledge transfer/communication exercise

Intended Learning Outcomes:
At the end of the module students understand the importance of aquatic resources for mankind and the variables which influence ecosystem functions as well as the principles of aquatic biodiversity conservation. They are able to analyze the effects of natural and man-made disturbances in aquatic ecosystems (e.g. overexploitation) based upon an interdisciplinary understanding of methodological aquatic
and fisheries biology, human dimensions, socioeconomic factors and management skills. In addition, students are able to objectively integrate knowledge from different disciplines (e.g. fish biology, conservation biology, commercial fishing techniques, aquatic habitat assessment and management) to evaluate sustainable resource management.

Teaching and Learning Methods:
The module combines a lecture "Fisheries Management" with an accompanying practical exercise "Applied Aquatic Conservation". The lecture contents will be presented using lectures based on power-point presentation, group work and interactive role plays in order to combine The module combines a lecture "Fisheries Management" with an accompanying practical exercise "Applied Aquatic Conservation". The lecture contents will be presented using lectures based on power-point presentation, group work and interactive role plays in order to combine activating teaching methods with classic presentation techniques. In the accompanying practical exercise to the lecture the students will apply the gained theoretical knowledge by conducting case studies or participating research experiments with various content in the field of freshwater ecology and aquatic conservation. The content of the practical work is incorporated into running research projects at the chair (e.g. habitat restoration, artificial breeding programs, habitat assessment, conservation genetics). Additionally, the students learn to independently screen the respective literature in this field and learn methods in science communication.

Media:
Form of presentation: lecture, case study, movie segment and practical exercise
material: lecture notes, flip-chart/board, plus different materials for methodological/technical training

Reading List:
1. King (2007) Fisheries Biology, Assessment and Management
2. Helfman (2007) Fish Conservation: A guide to understanding and restoring global aquatic biodiversity and fishery

resources
3. Moyle & Cech (2004) Fishes An introduction to Ichtyology
4. Primack (2008) A primer of conservation biology

Responsible for Module:
Geist, Jürgen; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Fisheries Management (Vorlesung, 2 SWS)
Geist J

Applied Aquatic Conservation (Übung, 2 SWS)
Geist J [L], Kalis E, Knott J, Pander J
For further information in this module, please click campus.tum.de or here.

Module Description

LS10051: Genetics and Genomics of Root-Microbe Interactions | Genetics and Genomics of Root-Microbe Interactions [GGRMI]

Version of module description: Gültig ab summerterm 2025

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a presentation of contents and results of a project in a 15-minute oral report (40%), including subsequent discussion (30%) and a preparation of a written report containing the content and results of the project (30%). The presentation is a means to measure the student’s ability to understand a technical/scientific subject, to analyze and evaluate facts and factors of influence, to summarize the subject and present it to an audience, and to conduct a subsequent discussion on critical thinking and innovative outcome about the presented subject. Written reports measure the student’s ability to summarize the major facts and the conclusion of a presentation in a clear and concise manner, both in a short abstract (150 words) and in a one-page executive summary.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
The students are expected to have the basic knowledge of biology, genetics and genomics.

Content:
The proposed content of this module is listed below with coherent items:
• Genetic basis of root development and rhizosphere formation;
• Root functional genomics: root transcriptomics and metagenomics;
• Hormonal role on root development and rhizosphere interactions;
• Rhizosphere microbiome and beneficial functions;
• Root exudations as the chemical signal for plant-microbe interactions;
• Gene regulation of plant-microbe interactions;
• Rhizosphere microbiome derived plant-soil feedback;
• Translational root genetics and genomics for sustainable agriculture;

• Microbiome and One Health;
• Advance techniques of root genetics and genomics: single-cell sequencing, computational root biology, high-throughput bacterial functional validation.

Intended Learning Outcomes:
• Upon successful completion of this module, students are able to understand the genetic and genomic basis of the formation and function of the root systems in association with rhizosphere microorganisms;
• Based on the acquired theoretical knowledge and bioinformatics, students are capable to analyze the root transcriptome and rhizosphere microbiome data analysis;
• After the professional and technical skills training in the lab, students will be able to apply genome-editing and microbial cultivation strategies to resolve the key root-expressed genes in mediating beneficial root-microbe interactions;
• After completion of this module, students can evaluate and judge the major scientific questions and experimental strategies to address the major scientific goal of a new research topic;
• Finally, successful completion of all tasks in this module will allow students to independently design and plan a research project in targeting the complex interactions of roots and microbiome.

Teaching and Learning Methods:
Several complementary teaching methods will be employed for this course. The basic root development, genetic and genomic understanding of root and microbiome interactions will be delivered to students by lecture series. The open questions of root-rhizosphere interactions will be discussed among different group of students by teamwork, literature searching followed by research presentations and discussions among different groups. Acquisition of technical skills will be implemented via laboratory-based experiments and lab practical courses. Finally, the students will be directly allocated to some ongoing projects and directly guide the students to be involved into the current ongoing research topics.

Regular discussions with an assigned supervisor (research assistant) are offered about the progression of the project and the next steps. This helps the students to develop an idea from the initial concepts to the complete picture within a given timeframe.

Media:
PowerPoint, slides and exercise sheets, literature

Reading List:
Root Genomics and Soil Interactions - edited by Crespi, M. 2013. WILEY-BLACKWELL
Plant Roots: The Hidden Half. 5th rev. ed. Beeckman, Tom and Amram Eshel (eds.) 2024. CRC Press.
Microbial Cross-talk in the Rhizosphere. eds. Benjamin A. Horwitz and Prasun K. Mukherjee. 2022. Springer Press.
Actual articles from scientific journal will be provided.

Responsible for Module:
Yu, Peng, Prof. Dr. pengyu.yu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1084: Poultry Science | Geflügelwissenschaften

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer 30-minütigen mündlichen Prüfung erbracht. In dieser soll nachgewiesen werden, dass physiologische Abläufe und anatomische Besonderheiten des Geflügels verstanden wurden. Darüber hinaus sollen verschiedene Funktionen des Immunsystems im Kontext mit wichtigen Krankheiten des Geflügels beschrieben werden und weiterführende Fragen hierzu beantwortet werden können. Die Interaktion von Krankheitserregern mit dem Immunsystem soll erklärt und bewertet werden. Insbesondere die Zusammenhänge zwischen Haltung, Physiologie, Immunsystem und Krankheiten soll durch die Studierenden dargelegt und bewertet werden.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Grundkenntnisse der allgemeinen Tierwissenschaften

Content:
In dem Modul Geflügelwissenschaften werden aktuelle Aspekte der Geflügelhaltung, Zucht, Reproduktionsbiologie als auch Grundlagen der Anatomie, Physiologie, Infektionsmedizin und Immunologie gelehrt. Im Einzelnen werden folgende Themenkomplexe behandelt:
- Grundlagen der Anatomie des Geflügels;
- Systematik;
- Physiologie;
- Pathophysiologie;
- Zucht von Geflügel;
- Haltung von Geflügel;
- Bestandsbetreuung;
- Immunsystem des Geflügels;

- virale Erkrankungen;
- bakterielle Erkrankungen;
- parasitologische Erkankungen;
- Seuchenrechtliche Aspekte in Bezug auf Erkrankungen;
- Reproduktion von Geflügel;

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage:
- den anatomischen Aufbau des Geflügels zu erinnern,
- verschiedene physiologische Aspekte des Geflügels zu verstehen,
- verschiedene Ansätze der Immunologie des Geflügels zu bewerten,
- verschiedene Krankheiten, Haltungsformens und Zuchtformen des Geflügels zu bewerten.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung in welcher eine Basis geschaffen wird auf welcher die Studenten nach erfolgreicher Teilnahme dazu in der Lage sind die Grundprinzipien der Geflügelwissenschaften zu verstehen. Eine Vorlesung bietet sich an um die große Vielfalt an unterschiedlichen Themen zu vermitteln und vertiefend zu diskutieren.
Im Rahmen einer Exkursion kann das in der Vorlesung erlernte Wissen anhand von Fallbeispielen in der Praxis angewandt werden. Die Bewertung von Krankheitsbildern und immunologischen Fragestellungen wird ebenfalls anhand von Fallbeispielen im Rahmen der Exkursion angewandt.
Die Kombination aus Vorlesung und Exkursion soll die Studenten optimal in das Gebiet der Geflügelwissenschaften sowohl auf wissenschaftlicher als auch praktischer Ebene einführen.

Media:
PowerPoint

Reading List:
Antatomie der Vögel, Schattauer; Physiologie der Haustiere, Enke; Diseases of Poultry, Wiley; Sturkie's Avian Physiology, Elsevier;

Responsible for Module:
Schusser, Benjamin; Prof. Dr.med.vet.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1035: Host-Parasite-Interaction | Host-Parasite-Interaction

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module is rated via written examination, Klausur, (essay exam, no multiple choice, without the use of learning aids, (100 % of the grade; 90 min). The exam tests the ability of the students to transfer the deep knowledge of principles of molecular plant pathogen interaction on new scientific questions. Students have to show their ability to design experiments suitable to test a given hypothesis from molecular host-parasite interactions. Students have to show in how far they are able to extract scientific progress from original data or experiments presented in the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of Plant Sciences and Phytopathology at the B.Sc. Level

Content:
In this modul, students reach a deep understanding of plant-pathogen interaction at the molecular level. This comprises pattern-triggered immunity, effector-triggered susceptibility, effector-triggered immunity and translational research. This is not restricted to model plants but extends to crops and fills the gap between basic research and applied plant sciences in breeding and biotechnology for disease resistance. In interactive learning structures with small groups, we train reading and understanding of original literature (Journal Club). In the practical course, we learn real time PCR, plant immune response assays, transient transformation of plants, cell biology of plant defense reactions, etc.

Intended Learning Outcomes:
Education to become a molecular plant pathologist, who is able to judge and design approaches for increasing disease resistance in model and crop plants.
Upon successful completion of the module, students are able

- to understand the molecular basis of plant pathogen interactions in depth.
- to transfer theoretical background and definitions of molecular host parasite interactions.
- to analyze plant immune responses.
- to collect new theoretical knowledge from literature and understand innovative technologies in plant immunity and susceptibility.
- to carry out key molecular methods for quantification of plant immune reactions and disease susceptibility (e.g. real time PCR, reactive oxygen measurement, transient transformation of plants, cell biology of plant defense reactions) in hands-on experience
- to generate experimental design and carry out evaluation of plant disease resistance tests in model and crop plants.

Additionally, students are able to process and present complex information from original literature.

Teaching and Learning Methods:
In the lecture students gain knowledge about theoretical background of plant parasite interactions, which is extracted and focussed by the lecturers from review literature. In the exercise, students practise in small groups key methods for quantification of plant immune reactions and disease susceptibility. They make hands-on experience, practise the use of molecular methods and devices, document their data under guidance and discuss them with group members and supervisors. In the journal club, students are guided in small groups how to critically read original research papers, digest information and present most central findings from a recent original paper.

Media:
PowerPoint

Reading List:
Buchanan 2015: Biochemistry & Molecular Biology of Plants. Review literature provided

Responsible for Module:
Hückelhoven, Ralph; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Host-Parasite-Interaction (Seminar, 2,5 SWS)
Hückelhoven R, Hein S, Maroschek J, Müller M, Steidele C

Host-Parasite-Interaction (Vorlesung, 1,5 SWS)
Hückelhoven R, Steidele C
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1075: Herbicides and Plant Physiology | Herbizide und Pflanzenphysiologie

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination consists of a 90-minute written exam. In the exam, students demonstrate that they understand herbicides in their application and effects in plant protection, that they can consider environmental aspects of herbicide application and that they can present and discuss the main advantages and disadvantages in a structured way. In addition, the students should develop a plan for the use of herbicides using concrete case studies and environmental conditions and assess the associated risks. Answering the questions requires students to formulate their own answers, and if necessary, to tick the appropriate boxes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
For a better understanding of the lecture, knowledge of plant physiology is required, basic knowledge of agricultural production is useful.

Content:
* Herbicide classification and use, herbicide action (mode of action) and compounds related to plant metabolism.
* Development of different herbicide classes, sites of action and principles of action
* Methods of approval, testing and legal basis of herbicide use
* Molecular basis of herbicide action in plant metabolism
* Application technique and combinations of active ingredients
* Weed control in conventional, integrated and ecological systems
* Ecotoxicology of herbicides, fate in the environment and herbicide metabolism.

Intended Learning Outcomes:
After successful participation in the module, students will have the basic theoretical knowledge of herbicides, their application and effects in crop protection.
They are able to
- distinguish herbicide classes, selectivity and principles of action
- to assess herbicide damage to individual plants and stands
- describe the molecular basis of the effect and present resistance and tolerance
- to apply the legal basis and the principles of Integrated Pest Management
- take measures to reduce losses and plan site-specific application (climate, soil, damage thresholds)
- to explain how active ingredients enter different environmental compartments after application, how they are detoxified by plants and soil-borne microbes, and how herbicide residues remain in the environment.

Students are able to plan the use of herbicides on concrete application cases and are able to analyze and evaluate it according to performance and sustainability criteria.

Teaching and Learning Methods:
The module consists of a lecture and an accompanying exercise. The contents of the lecture are conveyed in the lecture and through presentations. Students should be encouraged to study literature and the content-related discussion of the topics become. During the field exercises on the experimental farms, concrete questions are answered and selected examples are worked on (e.g. identification of weeds, cultivation methods, soil types, weather data, application methods, alternative measures).

Learning activities: Study of lecture notes, lecture notes and literature; answering key questions provided in Moodle. This helps students to orientate themselves about their learning progress, to control their understanding and to develop the ability to describe, evaluate and interpret the knowledge acquired in self-study.
The exercise allows students to gain insights into practical aspects of crop protection. Trial fields and manufacturers are visited, assessments are carried out, herbicide application and loss-reducing measures are observed. Conditions for application (climate, soil, status of plants, damage thresholds) are critically evaluated. Concrete situations are analyzed in the overall scientific and technical context and evaluated ecologically and economically.

Media:
Presentation, script, field trips

Reading List:
There is no textbook available that covers all contents of this module. Recommended: Hock, Fedtke, Schmidt (1995) Herbicides. Georg Thieme publishing house Stuttgart; Zwerger P; Ammon HU. (2002) Weeds - Ecology and Control. Ulmer. Stuttgart; Martin Hanf (1999) Field weeds of Europe: With their seedlings and seeds. Ulmer, Stuttgart; Andrew Cobb (2010), Herbicides and Plant Physiology, Chapman and Hall

Responsible for Module:
Apl. Prof. Dr. Peter Schröder (peter.schroeder@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

MGT001434: Introduction Remote Sensing in Life Science | Introduction Remote Sensing in Life Science

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination takes the form of a presentation (~15 min) on the case study carried out by the student, which is supplemented by a written report (4-5 pages). By presenting an individual case study based on their own interest, students prove that they understand the potential of image processing and analysis. They show that they are able to use open source software to perform remote sensing image processing and analysis. By conducting the case study based on their own interest, they show their ability to select remote sensing data and analysis approaches based on specific problems to be solved.
The written report (4-5 pages) is an integral part, but its purpose is to complement and reinforce the findings presented orally. In the report, students are expected to provide a detailed account of the methods used in their case study, together with the results and their interpretation. This dual assessment approach ensures a comprehensive evaluation of students' skills, with the oral presentation acting as the focal point for assessing their communication skills, understanding of remote sensing principles and ability to apply image processing techniques. Ultimately, the aim is to validate that students can effectively communicate their analytical processes and results, thereby enhancing their overall understanding of the subject for future applications in remote sensing projects.

The final grade will be an averaged grade from the presentation (60 %) and the written report (40 %).

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge in R and GIS

Content:
Remote sensing is crucial in life sciences as it allows for non-invasive monitoring and assessment of the Earth's surface, enabling the study of dynamic biological processes, habitat mapping, and biodiversity monitoring. This course provides a comprehensive understanding of the theoretical and practical foundations of remote sensing, covering optical remote sensing, different sensor systems, properties of remote sensing data, and image processing and classification techniques. Emphasizing hands-on learning, this seminar includes practical applications. We will use open-source software and coding approaches throughout the course.
Understanding the importance of remote sensing in the life sciences, we'll explore its role in monitoring ecosystems, tracking changes in land use, and studying biodiversity patterns. This knowledge is central to advancing research in fields such as agriculture, ecology and environmental science.

Intended Learning Outcomes:
Remote sensing is crucial in life sciences as it allows for non-invasive monitoring and assessment of the Earth's surface, enabling the study of dynamic biological processes, habitat mapping, and biodiversity monitoring. This course provides a comprehensive understanding of the theoretical and practical foundations of remote sensing, covering optical remote sensing, different sensor systems, properties of remote sensing data, and image processing and classification techniques. Emphasizing hands-on learning, this seminar includes practical applications. We will use open-source software and coding approaches throughout the course.
Understanding the importance of remote sensing in the life sciences, we'll explore its role in monitoring ecosystems, tracking changes in land use, and studying biodiversity patterns. This knowledge is central to advancing research in fields such as agriculture, ecology and environmental science.

Teaching and Learning Methods:
The course is designed in a non-traditional way and is conducted as a weekly 4 SWS seminar. Each class starts with an introduction to the key concept of that day's topic. To reinforce the theory and make it applicable, the topic is then explored in depth through a practical session.
Towards the end of the semester, students will conduct a mini case study based on their interests where they apply the methods and concepts discussed during the course. At the end of the semester, students will give a presentation and hand in a report on their mini-case studies.

Media:
PowerPoint

Reading List:
Wegmann M. et al. (2016). Remote Sensing and GIS for Ecologists: Using Open Source Software. ISBN: 9781784270223

Responsible for Module:
Cabernard, Livia; Prof. Dr.sc. ETH Zürich

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction Remote Sensing in Life Science (MGT001434, englisch) (Seminar, 4 SWS)
Schlosser V
For further information in this module, please click campus.tum.de or here.

Module Description

WI000321: International Commodity Markets and Trade Policy | International Commodity Markets and Trade Policy [ICMTP]

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The learning success will be assessed by a written exam (90 minutes)..
By answering the questions students show that they are able to understand the price adjustment mechanisms on international commodities markets. Furthermore students show that they understand how price trends and price volatility of the major agricultural commodities changed in the past. They demonstrate that they understand the influence of changes in exchange rates on international commodity markets and the role of speculation and hedging on commodity futures markets. Finally students show that they are able to assess the welfare implications of trade policies and demonstrate that they understand the political economy of protected agricultural markets in both developing and developed countries, and of the World Trade Organization.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Attendance of a module dealing with the microeconomic theory of demand and supply

Content:
The module covers the following topics:
a) price adjustment mechanisms on commodity markets
b) price trends on the major agricultural commodity markets
c) price volatility
d) hedging on future markets
e) exchange rates
f) international trade theory
g) international trade policy instruments
h) domestic policies influencing international trade

i) political economy of protection
j) World Trade Organization

Intended Learning Outcomes:
After successful completion of the module students are able..
- to understand the price adjustment mechanisms on international commodities markets that are due to changes in both supply and demand.
- to understand how price trends and price volatility of the major agricultural commodities changed in the past, and understand the main determinants behind these changes.
- to understand the interactions between different international commodity markets and know the influence of changes in exchange rates on these markets.
- to understand the role of speculation and hedging on commodity futures markets, how different government interventions affect commodity markets and influence the welfare of consumers, producers and tax payers.

Therefore, students are able to apply economic theory to current issues to assess the welfare implications of trade policies, both qualitatively and quantitatively. Furthermore, they will have an understanding of the political economy of protected agricultural markets in both developing and developed countries, and of the World Trade Organization.

Teaching and Learning Methods:
The module will be held in the form of lectures which are partially combined with group discussions and exercises. The main learning objective is here to understand economic principles to better understand the market situation in practice. Lectures are a format suitable to convey theoretical knowledge about the price adjustment mechanisms on agricultural commodity markets. Exercises will help students to apply acquired knowledge to concrete problems and derive economically sound answers.

Media:
PowerPoint

Reading List:
Selected passages from text books (Moodle): Among many others: Lipsey, R. and K. Chrystal (1995): Positive Economics. Oxford University Press.
Koo, W.W. and P.L. Kennedy (2005). International Trade and Agriculture;
Reed, M. (2001). International Trade in Agricultural Products;
Rose, K. and K. Sauernheimer (1999). Theorie der Außenwirtschaft;
Södersten, B. and G. Reed (1994). International Economics.

Responsible for Module:
Glebe, Thilo; PD Dr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
International Commodity Markets and Trade Policy (WI000321, englisch) (Vorlesung mit integrierten Übungen, 4 SWS)
Glebe T [L], Glebe T
For further information in this module, please click campus.tum.de or here.

Module Description

WI001190: Cooperation and Integration in Agribusiness | Kooperation und Integration im Agribusiness

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer 120-minütigen Klausur erbracht. In der Klausur soll nachgewissen werden, dass die theoretische Konzepte zur Kooperation und Integration im Agribusiness (z.B., verschiedene Ansätze der institutionellen Ökonomie) verstanden und relevante analytische Methode zur Problembewältigung angewendet werden. Dazu sollen die Studierenden nachweisen, dass sie praxisnah Probleme analysieren, die verschiedenen Kooperations- und Netzwerkformen im Agribusiness beurteilen, und entsprechende Lösungsvorschläge für strategische Kooperationen und Integrationen entwickeln können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen der Mikroökonomie, Grundlagen der Marktlehre (Bachelor Studiengang)

Content:
Das Modul vermittelt die komplexen Formen und Ansätzen von Kooperationen und Integrationen im Agribusiness, um die Leistungen der landwirtschaftlichen Unternehmen zu verbessern.
Spezifische Themen des Moduls sind:
• Theoretische Ansätze und Grundlagen der Kooperationen und Integrationen mit dem Fokus auf verschiedene Ansätze der institutionellen Ökonomie (Ressourcenbassierter Ansatz, Transaktionskostenökonomie, Vertragstheorie, Prinzipal-Agent-Ansatz und Interventionen und Governance-Formen im Bereich der Lebensmittelzertifizierungen)
• Strategische Optionen der horizontale und vertikalen Integrationen
• Formen des Beziehungs- und Stakeholdermanagement in Unternehmen und der soziale Netzwerkansatz
• "Lean Management" und unternehmerische Kooperationen

• Nachhaltigkeit in der Wertschöpfungskette und unternehmerische Kooperationen

Intended Learning Outcomes:
Nach Absolvieren des Moduls sind die Studierenden in der Lage:
• die Kooperationsdynamik, Probleme, Lösungen und Herausforderungen in vertkalen und horizontalen Kollaborationen zu verstehen,
• relevante qualitative und quantitative Methoden (z.B., Netzwerkanalyse, "value stream mapping", verschiedene ökonometrische Ansätze) zur Analyse und Verbesserung der unternehmerischen Kooperationen und Integrationen zu verwenden,
• Agribusiness bezogene Kooperationen und horizontale und vertikale Integrationen zu analysieren und zu beurteilen,
• Strategien für effektive unternehmerische Kollaborationen und Integrationen zu entwickeln und gestalten

Teaching and Learning Methods:
Vorlesung, Einzelarbeit, Gruppenarbeit und Fallstudie.
Mit Hilfe der Vorlesung werden die Modulinhalte vermittelt. Einzelarbeiten, Gruppenarbeiten und Fallstudien werden zum bearbeiten von Problemen und deren Lösungsfindung benutzt. Dies schließt auch das Lernen durch Literaturarbeit und Übungen ein.

Media:
Präsentationen, Fallbeschreibungen, Skript

Reading List:
Adebanjo, D. 2009. Understanding demand management challenges in intermediary food trading: a case study. Supply Chain Management: An International Journal, 14(3): 224 – 233
Fischer, F., et al. (2010), Factors influencing contractual choice and sustainable relationships in European agri-food supply chains. European Review of Agricultural Economics, 36(4): 541-569
Gall, R. G. and Schroder, B. (2006). Agricultural Producer Cooperatives as Strategic Alliances. International Food and Agribusiness Management Review, 9 (4): 26-44.
Gereffi, G., Humphrey, J. and Sturgeon, T. (2005). The Governance of Global Value Chains. Review of International Political Economy, 21(1): 78-104

Mugera, A. W. (2012). Sustained Competitive Advantage in Agribusiness: Applying the Resource-Based Theory to Human Resources. International Food and Agribusiness Management Review, 15(4): 27-48
Peterson, C. et al (2001). Strategic choice along the vertical coordination continuum. International food and agri-business review, 4:149-166
Polonsky, M.J. et al. (2002). A Stakeholder Perspective for Analyzing Marketing Relationships. Journal of Market-Focused Management, 5:109–126
Porter, M.E. (1985), Competitive Advantage: Creating and Sustaining Superior Performance, Free Press, New York.

Schulze, et al. 2006. Relationship quality in agri-food chains: Supplier management in the German pork and dairy sector. Journal on Chain and Network Science, 6:55-68
Soon, J.M. and Baines, R.N. (2013). Public and Private Food Safety Standards: Facilitating or Frustrating Fresh Produce Growers? Laws 2: 1–19
Trienekens, J. and Zuurbier, P. (2008). Quality and safety standards in the food industry, developments and challenges. Int. J. Production Economics, 113: 107–122
Torres, J. et al. (2007). An Evaluation of Customer Relationship Management (CRM) Practices Among Agribusiness Firms. International Food and Agribusiness Management Review, 10(1): 36-56
Walters, D. and Rainbird, M. (2007). Strategic Operations Management. Palgrave Macmillan
Weber, A. (2011). „Why do farmers spend different amounts of transaction costs in agri-environmental schemes?“
Williamson, Oliver E. 1979. Transaction-Cost Economics: The Governance of Contractual Relations. Journal of Law and Economics, 22(2): 233–61.
Die Liste wird anhand von weiteren thematisch relevanten Büchern, Zeitschriftenartikeln und aktuellen Themen aktualisiert.

Responsible for Module:
Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Kooperation und Integration im Agribusiness (WI001190, deutsch) (Vorlesung, 4 SWS)
Abate Kassa G [L], Abate Kassa G
For further information in this module, please click campus.tum.de or here.

Module Description

WZ4225: Concepts and Research Methods in Ecology | Konzepte und Forschungsmethoden der Ökologie

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination is a written exam (180 minutes). In the written exam, students demonstrate that they have understood the terms, concepts, and ecological mechanisms presented, the basic principles of biogeochemical cycles, and the role of anthropogenic influences on individual organisms, populations, and biotic communities. They will be able to explain these and illustrate them with their examples. In addition, the concepts introduced in the course should be applied to species conservation problems (e.g., land use scenarios). Finally, students should demonstrate that they can analyze and evaluate ecosystem and resource management questions about the composition of species communities.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic lecture in the field of biology (physiology, evolution)

Content:
The module is divided into two parts ("Introduction to Ecology" and "Community Ecology"). The lecture "Introduction to Ecology" is dedicated to the basics of ecology and includes sessions on auto-, population-, community- and functional ecology as well as global material cycles.
The exercise "Community Ecology" analyzes biological communities, records biological diversity, and investigates human influence on biological communities.

Intended Learning Outcomes:
After successfully completing the module, students will be able to define important terms in auto- and population ecology, community ecology, and global ecology and discuss the role of ecology in solving applied problems. Students can describe basic ecological and evolutionary terms,

concepts, and mechanisms, e.g., dispersal, speciation, evolution of traits, microbiome, population dynamics, niche theory, natural selection, competition, predation, and mutualism in their own words. In addition, they understand the basic principles of biogeochemical cycles influenced by human land use and climate change and can discuss the causes and consequences of the current biodiversity crisis.

Teaching and Learning Methods:
The module is designed to engage students through varied active learning activities. The sessions are organized according to a recurring structure: Inputs are in the form of lectures, followed by applied sessions with exercises, reading of scientific articles followed by discussions and/ or debates. Key concepts will be introduced in the lectures, while the active learning activities will focus on deepening selected topics and consolidating the understanding of the concepts introduced in the lectures.

Media:
Moodle, lectures (and associated set of slides), simulations on the computer

Reading List:
Ökologie: Begon, Michael ; Howarth, Robert W. ; Townsend, Colin R. 3. Auflage [2017] https://doi-org.eaccess.tum.edu/10.1007/978-3-662-49906-1

Ökologie Globale Einblicke und Untersuchungen 2012 Peter Stiling New York Mc Graw Hill https://archive.org/details/ EcologyGlobalInsightsAndInvestigations2012PeterStilingNewYorkMcGrawHill120mb.

Responsible for Module:
Weißer, Wolfgang; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Ecology (Vorlesung, 2 SWS)
Meyer S [L], Meyer S, Mak B

Community Ecology (Übung, 4 SWS)
Weißer W [L], Meyer S, Weißer W

Community Ecology (Übung, 4 SWS)
Weißer W [L], Meyer S, Weißer W
For further information in this module, please click campus.tum.de or here.

Module Description

LS10042: Lab Course Plant Immunology and Stress Physiology | Lab Course Plant Immunology and Stress Physiology

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module is rated via written examination (Klausur, essay exam, no multiple choice, without the use of learning aids, 100% of the grade, 90 min). The written exam tests the ability of the student to remember the principles, power and limitations of technologies for testing immunological and stress physiological parameters. They have to show their ability to transfer the knowledge on new practical problems and scientific questions. Student have to show their ability to design experiments suitable to test a given hypothesis from the plant stress and immunity field. Students have to show their ability to extract scientific conclusions from experimental data presented in the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of plant stress physiology and immunology. Ideally, successful completion of one of the M.Sc. modules: Immunology, Crop and Livestock Health and Disease, Host-Parasite-Interaction, or Plant Stress Physiology. Basic experience in laboratory techniques, such as pipetting, working with standard laboratory equipment, data processing and display.

Content:
In this module, students are introduced to planning and performing immunological and stress physiological experiments in order to analyze the immune system and stress responses of plants. Students gain knowledge about theoretical background, power and limitations of technologies applied.
Examples of methods/technologies usually performed during the exercise are:
- Measuring calcium signaling in plants
- Measuring reactive oxygen species

- Transfection of plants for interference with immuno-competence
- Measuring of stress hormone ethylene
- Measuring of chlorophyll fluorescence
- Phenotyping plant immune competence
- Measuring MAP Kinase activation

Data are collected in small groups of students. Students process and evaluate own and peers´ data for short supervised presentation and discussion.

Intended Learning Outcomes:
Upon completion of the module, students know and understand state of the art technologies in plant immunity and stress physiology. They made hands on experience in laboratory technologies in plant immunity and stress physiology. They are able to self- sufficiently select and apply suitable methods from literature and exercises for measuring plant immunity and stress and to evaluate and interpret data. Students know advantages and disadvantages of different methods for judging a plant´s stress and immune status. They can interpret and display own data and discuss them in front of an audience of peers. This enables students for measuring and judging plant performance under adverse environmental conditions and pathogen pressure.

Teaching and Learning Methods:
The module consists of two consecutive one-week lab courses on plant immunology and stress physiology. Theoretical background is introduced by supervisors/tutors on a daily basis. In small parallel groups, the students will be guided by each one supervisor/tutor to plan and conduct experiments in order to analyze the a) plant immune system and b) stress responses. The students will perform supervised hands-on experiments and analyze the resulting data in a guided way. Analyzed data will be presented to the supervisor and the group and results are critically discussed.

Media:
We provides scripts, protocols, and data processing templates. We present in PowerPoint and round table discussion.

Reading List:
Buchanan 2015, Biochemistry & Molecular Biology of Plants. Review and original literature are additionally provided.

Responsible for Module:
Hückelhoven, Ralph, Prof. Dr. rer. nat. hueckelhoven@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
lab course plant immunology (Übung, 2 SWS)
Schempp H, Müller M, Steidele C, Hoheneder F, Maroschek J, Hein S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1993: Laboratory Animal Science | Laboratory Animal Science [VTK]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination consists of a written exam (Klausur, 90 min) in which students have to answer various questions on laboratory animal science topics without any aids. Answering the questions partly requires students to formulate their own answers and partly requires them to mark multiple answers.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of Anatomy, Physiology, Laboratory Animal Science, BSc Biology/Life Sciences, BSc Molecular Biotechnology, BSc Agricultural and Horticultural Sciences, BSc Nutritional Sciences

Content:
The following topics are covered in the module:
- Laws relating to animal testing
- Exposure assessments and score sheets
- Alternative methods to animal testing
- Blood collection and application techniques
- Genetics and breeding in animal experiments
- Biotechnological techniques in pigs and chickens
- Poultry as laboratory animals
- Bats as laboratory animals
- Snakes as laboratory animals
- Monitoring of animal testing facilities
- Neurology and behavior of small rodents
- Handling of small rodents

- Injections (s.c., i.p. i.m. i.v.)
- Blood sampling techniques
- Oral application of substances

Intended Learning Outcomes:
After successfully attending the module courses, students will be able to name various procedures, relevant laws and methods of laboratory animal science. Students will be able to understand and apply these regulations after completing the module. Students will be able to assess the different interpretations and applications of laws, methods and animal models and actively support the planning of animal experiments. After completing the module, students will be able to carry out initial handling of laboratory animals such as mice, rats and rabbits and perform injections and blood sampling under supervision.

Teaching and Learning Methods:
The module consists of a seminar (2 SWS) and an exercise (2 SWS).
The seminar provides basic knowledge on the topics described. PowerPoint presentations are used to illustrate the most important aspects of the respective topics to the participants and are critically scrutinized in a subsequent discussion.
As part of the exercise, the handling of these rodent species is practiced using mouse, rat and rabbit models and blood sampling, as well as injections and applications of substances are practiced.

Media:
Presentation (PowerPoint), blackboard work, practical exercises

Reading List:
Lecture notes, legal texts, LAS-online course

Responsible for Module:
Schusser, Benjamin; Prof. Dr.med.vet.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0044: Methods in Agribusiness Management | Methoden im Agribusiness Management

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung besteht aus einem Bericht (ca. 15 Seiten) sowie dessen Präsentation und Diskussion. Die Studierenden weisen im Rahmens des Berichts ihre Fähigkeit nach, geeignete Konzepte und Methoden des Agribusiness für einen Anwendungsfall auszuwählen, einzusetzen und kompetent darzustellen. Dies schließt die kritische Beurteilung der Eignung, Stärken und Schwächen von Methoden des strategischen Management (z.B. SWOT, strategische Ausrichtung oder Planung, Szenarioentwicklung) für spezifische Agribusiness Fragestellungen ein. In der Präsentation zeigen die Studierenden, dass sie die Kernaspekte ihres Berichtes anschaulich und verständlich vor Fachpublikum darstellen und professionell diskutieren können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse von Unternehmensführung und Management, Organisation oder des strategischen Managements; Kenntnisse ökonomischer Konzepte und von deren Anwendung im Management

Content:
Aufgaben und Strukturen der Unternehmensführung im Agribusiness (einschließlich vor- und nachgelagerte Bereiche und Produktion);
Kompetenzen als Gesamtheit der Fähigkeiten und Fertigkeiten der Führungskraft anhand des Competing Values Framework;
Methoden des strategischen Managements (z.B. SWOT, strategische Ausrichtung oder Planung, Szenarioentwicklung) und deren Anwendung auf Agribusiness Fragestellungen;
beispielhafte Fallstudien mit konkreten Managementfragestellungen im Agribusiness.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden zu Folgendem in der Lage:
- Bandbreite möglicher Managementmethoden der Unternehmensführung einschätzen;
- beispielhafte Methoden zu erläutern (z.B. Analyse von Führungskompetenzen anhand des Competing Values Framework, SWOT, strategische Planung, Szenarioentwicklung);
- Einsatzbereiche der verschiedenen Methoden zu beurteilen;
- Managementaufgaben, Schlüsselkompetenzen und deren Zuordnung zu verschiedenen Führungsrollen zu verstehen und zu beurteilen;
- Managementmethoden im Agribusiness beispielhaft auszuwählen und anzuwenden;
- Fallstudien von Agribusinessunternehmen im Hinblick auf konkrete Fragestellungen kritisch zu analysieren und zu bewerten.

Teaching and Learning Methods:
Seminar mit Vorlesungselementen, Fallstudiendiskussion teilweise innerhalb von Gruppen; Vorträge von Studierenden mit Diskussion.
Durch die Vorlesungselemente werden im Agrarkontext geeignete Konzepte und Managementmethoden vermittelt; diese Konzepte und Methoden wenden die Studierenden während der Diskussion von Fallbeispielen, im Unterricht an; weiterhin lernen die Studierenden unterschiedliche (Unternehmens-)Perspektiven zu integrieren; durch Vorträge von Studierenden lernen die Studierenden weitere historische und aktuelle Konzepte und Methoden der Unternehmensführung abhängig vom Kontext kritisch zu beurteilen und anzuwenden.

Media:
Präsentationssoftware, Handouts und Texte, Videoclips, Flipcharts und andere Moderationsmedien, Fallbeschreibungen

Reading List:
Quinn, R.E. et al. (aktuelle Ausgabe). Becoming a Master Manager. Wiley (ausgewählte Kapitel)
Grant, R.M. aktuelle Ausgabe) Contemporary Strategy Analysis. Wiley (ausgewählte Kapitel).
Sowie aktuelle Artikel aus wissenschaftlichen Zeitschriften und Medien mit Zielgruppe Unternehmenspraxis

Responsible for Module:
Bitsch, Vera; Prof. Dr. Dr. h.c.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WI001215: Network and stakeholder analysis: Sustainable resource use and agri-food system | Netzwerk- und Stakeholderanalyse: Nachhaltige Ressourcennutzung und Agrar- und Ernährungssysteme

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 60	**Self-study Hours:** 150	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer 120-minütigen Klausur erbracht. In der Klausur weisen die Studierenden nach, dass sie die theoretische Konzepte verstanden und relevante analytische Methoden zur Problembewältigung anwenden können. Dazu zeigen die Studierenden, dass sie praxisnah Probleme analysieren, die verschiedenen Stakeholder- und Netzwerkformen im Ressourcenmanagement und in Agrar- und Ernährungssystemen beurteilen, und entsprechende Lösungsvorschläge für nachhaltige Kooperation und Integration entwickeln können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen in Kooperation und Nachhaltigkeit

Content:
Das Modul beschäftigt sich mit Netzwerk und Stakeholder-Theorien, Konzepten, Methoden und Indikatoren in Bezug auf nachhaltiges Ressourcenmanagement und Agrar- und Ernährungssysteme. Spezifische Themen des Moduls sind:

• Theorien und Konzepte von Netzwerken und Stakeholdern, um Struktur, Merkmale und Interaktionen zwischen Netzwerken und Stakeholdern zu verstehen und zu beschreiben und erläutern.

• Konzepte und Ansätze zur Untersuchung von Netzwerk- und Stakeholderzusammensetzungen, engagements, -konflikten und -einflüssen bei der Entwicklung und Umsetzung strategischer

Entscheidungen in Bezug auf nachhaltiges Ressourcenmanagement und Agrar- und Ernährungssysteme.

• Typen, Niveaus und Ausmaße von Risiken, die mit dem Engagement von Stakeholdern bei der Umsetzung von Projekten und Programmen im Zusammenhang mit Nachhaltigkeit verbunden sind.

• Spezifische methodische Ansätze, Instrumente und Indikatoren zur Bewertung, Evaluierung und Priorisierung der Leistungen und Auswirkungen verschiedener Netzwerk- und Stakeholder-Konstellationen.

• Weitere relevante aktuelle Netzwerk- und Stakeholder-Themen im Bereich nachhaltiger Innovationen, Ressourcenmanagement und Agrar- und Ernährungssysteme.

Intended Learning Outcomes:
Nach Absolvieren des Moduls sind die Studierenden in der Lage:
• die grundlegende Netzwerk- und Stakeholder-Theorien, -Konzepte, -Prinzipien und -Rahmenbedingungen im nachhaltigen Ressourcenmanagement und Agrar- und Ernährungssystem zu verstehen;
• relevante methodische Ansätze und Instrumente zu verwenden, um Netzwerk- und Stakeholder-Management bezogene Politik und Strategien zur Erreichung spezifischer nachhaltiger Ziele zu beschreiben;
• Typen, Niveaus und Ausmaß von Risiken zu analysieren, die mit dem Engagement und Management von Stakeholdern bei der Umsetzung von nachhaltigkeitsbezogenen Projekten und Programmen verbunden sind;
• Struktur, Merkmale und Auswirkungen verschiedener Formen von Netzwerken und Stakeholder-Gruppen auf das Outcome eines nachhaltigen Ressourcenmanagements sowie eines Innovations- und Agrar- und Ernährungssystems kritisch zu beurteilen und evaluieren.

Teaching and Learning Methods:
Das Modul umfasst Vorlesungen, Einzel- und Gruppenübungen, Leseaufgaben und Präsentationen. Die Vorlesungen bieten theoretische und konzeptionelle Grundlagen. In Einzel- und Gruppenübungen werden spezifische Netzwerk- und Stakeholder-Fragestellungen und deren Lösungen analysiert und diskutiert.

Media:
Präsentationen, Fallbeschreibungen, Skripte

Reading List:
Freeman, R.E (1984). Strategic Management: A stakeholder Approach. Boston.
Prell, C., K. Hubacek and M. Reed (2009). Stakeholder analysis and social network analysis in natural resource management. Society & Natural Resources 22(6): 501-518.
Chiffoleau, et al. (2014) Understanding local agri-food systems through advice network analysis. Agric Hum Values, 31:19–32

Lange, P. et al. (2015). Sustainability in Land Management: An Analysis of Stakeholder Perceptions in Rural Northern Germany. Sustainability, (7): 683-704.
Reed, M. S. et al. (2009). Who's in and why? A typology of stakeholder analysis methods for natural resource management.Journal of Environmental Management 90(5): 1933-1949.
Mcadam, et al. (2016). Regional Horizontal Networks within the SME Agri-Food Sector: An Innovation and Social
Network Perspective. Regional Studies, 50(8): 1316–1329
Katz, N. et al. 2004. Network Theory and Small Groups. Small Group Research, 35(3): 307-332.
Sandström, A. and C. Rova (2010). Adaptive co-management networks: A comparative analysis of two fishery conservation areas in Sweden. Ecology and Society 15(3): 14.
Bixler, et al. R (2016). Network governance for large-scale natural resource conservation and the challenge of capture. Frontiers in Ecology and the Environment 14(3): 165-171.
Bixler, R. P. et al.(2016). Networks and landscapes: A framework for setting goals and evaluating performance at the large landscape scale. Frontiers in Ecology and the Environment, 14(3): 145-153.
Ernstson, et al. (2010). "Scale-crossing brokers and network governance of urban ecosystem services: The case of stockholm." Ecology and Society, 15(4): 28.
Muñoz-Erickson, T. A. and B. B. Cutts (2016). Structural dimensions of knowledge-action networks for sustainability. Current Opinion in Environmental Sustainability, 18: 56-64.
Wubben, E. and Gohar Isakhanyan. (2011). Stakeholder Analysis of Agroparks. Int. J. Food System Dynamics 2(2), 2011, 145#154.

Die Liste wird anhand von weiteren thematisch relevanten Büchern, Zeitschriftenartikeln und aktuellen Themen aktualisiert

Responsible for Module:
Abate Kassa, Getachew; Dr. rer. hort.

Courses (Type of course, Weekly hours per semester), Instructor:
Netzwerk- und Stakeholderanalyse: Nachhaltige Ressourcennutzung und Agrar- und Ernährungssysteme (WI001215, deutsch) (Vorlesung, 4 SWS)
Abate Kassa G [L], Abate Kassa G
For further information in this module, please click campus.tum.de or here.

Module Description

WZ6417: Nature Conservation | Naturschutz

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Klausur (60 Minuten) fragt ab, ob die Studierenden die grundlegenden Herausforderungen des Biodiversitätsschutzes und die Konzepte zum Schutz der Natur verstehen und komprimiert wiedergeben können (siehe Lernergebnisse). Weiterhin fragt die Klausur ob, ob die Studierenden Lösungen zu konkreten Naturschutzproblemen auch unter zeitlichem Druck präzise aufzeigen können. Die Beantwortung der Fragen erfordert eigene Formulierungen.
Hilfsmittel: Büromaterial, Taschenrechner. Die Klausur bestimmt die Gesamtnote des Moduls.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse der Ökologie und Landschaftsplanung

Content:
Das Modul gliedert sich in eine Vorlesung und ein Seminar.
In der Vorlesung, die die im Bachelorstudiengang auf verschiedene Lehrveranstaltungen verteilten naturschutzfachlichen Grundlagen zusammenfasst und vertieft, haben aktuelle und internationale Aspekte des Naturschutzes eine besondere Bedeutung.

Folgende Themen werden in der Vorlesung behandelt:
- Kulturwissenschaftliche Grundlagen und Geschichte,
- Naturwissenschaftliche Grundlagen,
- Aufgaben des Naturschutzes,
- Objekte, Methoden und Konzepte des Naturschutzes,
- Planungswissenschaftliche Grundlagen: Rechtliche Instrumente im nationalen und internationalem Rahmen,

- Umsetzung und Management: Nationale und internationale Konflikte und Synergien, Naturschutz und Gesellschaft, Naturschutz im Spiegel aktueller Entwicklungen (z.B. Invasive Arten, Klimawandel)

Zweiter Teil des Moduls ist ein Seminar, in dem die Studierenden aktuelle Themen aus dem Bereich des Naturschutzes erarbeiten und präsentieren. Dieser Teil kann auch zur konkreten Vorbereitung des Masterprojektes genutzt werden.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen (Vorlesung und Seminar) sind die Studierenden in der Lage:
a) die Treiber des aktuellen Biodiversitätsverlustes zu verstehen,
b) die verschiedenen Motivationen für einen Schutz der Natur zu verstehen,
c) aktuelle Methoden der Naturschutzbiologie sowie Schutzstrategien auf konkrete Beispiele anzuwenden,
d) den Forschungsbedarf und das nötige Wissen bei einem Naturschutzproblem zu analysieren,
e) wissenschaftliche Texte zu aktuellen Naturschutzproblemen zu verstehen,
f) verschiedene mögliche Lösungen zu einem Naturschutzproblem zu entwickeln und zu bewerten

Teaching and Learning Methods:
Die Inhalte der Vorlesung werden durch die Dozenten vorgetragen, um einen Überblick über die Ursachen und Strategien der Überwindung des Biodiversitätsverlustes zu bekommen. Im Seminar werden Informationen zu aktuelle Themen des Naturschutzes von den Studierenden aus der Literatur recherchiert. Die Literatur wird zur Verfügung gestellt. Die Ergebnisse der Literaturanalyse werden den Mitstudierenden präsentiert und gemeinsam mit dem Dozenten ausführlich diskutiert.

Media:
Vorlesung: Power-Point-Präsentation, Skript; Seminar: Texte

Reading List:
Wird zu Beginn der Veranstaltung zur Verfügung gestellt.

Responsible for Module:
Weißer, Wolfgang; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar Naturschutz (Seminar, 2 SWS)
Weißer W [L], Schäffer N, Weißer W

Vorlesung Naturschutz (Vorlesung, 2 SWS)
Weißer W [L], Weißer W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0322: Ecological Colloquium: Scientific Foundations and Applications in Practice | Ökologisches Kolloquium: Wissenschaftliche Grundlagen und Anwendungen in der Praxis [SciTravels]

Overview of current research topics from local to global

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination consists of a written report (report of approx. 10 pages; 75% of the grade) and is supplemented by a presentation (approx. 20 min.; 25% of the grade). In the presentation, students should demonstrate that they can independently research and professionally present their findings. Through the written report, students should demonstrate that they can communicate specialized knowledge about ecology, conservation, biodiversity, sustainability, and resource use in writing. Students should also demonstrate that they can evaluate current problems and research questions as well as transdisciplinary connections between research, planning, nature conservation and environmental protection, politics and society in this subject area.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Depending on the topic, basic knowledge of landscape- , vegetation- , wildlife- , forest- or soil ecology, as well as climatology and land use is necessary.

Content:
The module consists of a seminar and a series of guest lectures by internationally or nationally renowned scientists. The guest lecturers presented selected topics on ecology, nature conservation, biodiversity, and sustainability research.

Students prepare for the lecture by reading the guest's publications and related studies. As part of the seminar, they introduce the respective guest and the topic and discuss the presentations in comparison with other contributions.
They also document how the specialist content is prepared and presented. Based on publications on the lecture topics and presentations, the students analyze the methods and techniques used by the scientists to convey their specialist content. This is done in a written report, which is produced at the end of the seminar.

Intended Learning Outcomes:
Upon successful completion of this module, students will be able to,
- understand sophisticated technical knowledge on diverse topics in the field of ecology, nature conservation and sustainable resource production and use;
- evaluate the quality of presentations by internationally or nationally recognized experts on selected topics in ecology, nature conservation, biodiversity and sustainability research according to methods and techniques, content and form;
- conduct research on the biography and professional focus of researchers, and
- present the results of their analysis and research efficiently and appropriately in a written report and to present and critically discuss them in a presentation.

Students will thus be able to critically evaluate current problems and research questions as well as transdisciplinary connections between research, planning and management, conservation and environmental protection, politics and society.

Teaching and Learning Methods:
The students prepare for the respective lectures by reading the publications of the visiting scientists and related studies. In a written report, they document how the technical content and other scientific topics are prepared and discussed. Building on the guests' CVs, publications and lectures, the students analyze the methods and techniques the scientists use to convey their specialist content. By critically analyzing publications and specialist lectures, students learn how scientists communicate their results to the public. By comparing and discussing several guest lectures as part of the seminar, students learn the essential techniques for efficiently conveying specialist knowledge verbally and in writing. The combination of oral presentation and written report meets the requirements profile of graduates in the professional fields of ecosystem management, nature conservation, landscape planning and public relations.

Media:
PowerPoint presentations, script, original scientific articles, students' own presentations.

Reading List:
Topic-specific literature for the seminar will be announced.

Responsible for Module:
Leonhardt, Sara Diana; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Weihenstephaner Kolloquium zur Angewandten Ökologie und Planung (Kolloquium, 2 SWS)
Häberle K, Kollmann J, Seidl R, Annighöfer P, Leonhardt S, Pauleit S, Grams T, Rufino M, Geist J, Menzel A, Rammig A, Egerer M, Schloter M

Seminar Wissenschaftliche Grundlagen und Anwendungen in der Praxis (Seminar, 2 SWS)
Leonhardt S [L], Kollmann J, Häberle K
For further information in this module, please click campus.tum.de or here.

Module Description

LS10034: Process and Product Quality in the Production of Animal Based Foods | Prozess- und Produktqualität in der Erzeugung tierischer Lebensmittel

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Klausur (60 min) erbracht. In dieser sollen Kenntnisse über die Erzeugung von Lebensmitteln über die gesamte Kette z.B. Fleisch vom Tier bis zum Schlachthof nachgewiesen und zur Beurteilung konkreter Fälle genutzt werden. Darüber hinaus sollen Grundprinzipien des Qualitätsmanagements, sowie Aspekte der Lebensmittelsicherheit und des Verbraucherschutzes bei Lebensmitteln, wie Fleisch, Milch und Eiern erklärt und an konkreten Beispielen angewendet werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor Agrarwissenschaften oder äquivalenter Abschluss

Content:
Das Modul besteht aus zwei zusammen gehörenden Teilen: Teil 1: Qualität in der Erzeugung tierischer Lebensmittel
-Prinzipien der Risikobewertung und des Qualitätsmanagements
- Physiologie des Wachstums landwirtschaftlicher Nutztiere
- Beeinflussung von Schlachtkörper- und Fleischqualität durch die Tierernährung, Alter und Geschlecht
- Erfassung dieser Parameter am Schlachthof, praktische Untersuchungen zur Produktqualität Tierwohl und Nachhaltigkeit im Erzeugungsprozess Carry-over Effekte von UmweltkontaminatenTeil 2: Lebensmittelsicherheit und Qualitätsmanagement
- Mikrobiologie von Lebensmitteln tierischen Ursprungs
- unerwünschte Substanzen in Lebensmitteln tierischen Ursprungs

- Hygienemaßnahmen

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage, die bestimmenden Faktoren der für den Landwirt und den Konsumenten relevanten Aspekte der Schlachtkörper- und Fleischqualität sowieder Milch- und Eiqualität zu analysieren und geeignete Möglichkeiten einer gezielten Steuerung zu vorschlagen. Darüber hinaus können die Studierenden Produktionsabläufe nach hygienischen Kriterien bewerten und gegebenenfalls Verbesserungskonzepte entwickeln.

Teaching and Learning Methods:
Vortrag: Vermittlung von reproduzierbaren Inhalten; Einzelarbeit, fallweise unterstützt durch praktische Übungen inkl. Protokollerstellung: kritische Beurteilung von Situationen und Methoden

Media:
PowerPoint-Präsentation, Anleitungen für die praktischen ÜbungenFallbeschreibungen, moodle-Kurs

Reading List:
Auf spezifische Literatur wird am Ende der jeweiligen Folien verwiesen

Responsible for Module:
Steinhoff-Wagner, Julia, Prof. Dr.sc.agr. jsw@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

MGT001437: Programming in Python for Business and Life Science Analytics | Programming in Python for Business and Life Science Analytics

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
This seminar is assessed by Project Work. Students have the option to either work with the real-life analysis examples we provide, such as cost optimization for a company, or choose topics related to business or life sciences that interest them for data collection, analysis, and enhancement.
The project work consists of a project report and a supplementary short presentation (shorter than 15 minutes) in week 8, in which each group must present their project´s initiation, problem definition, and role distribution (10% of the overall grade).
The project report is divided into two parts, with each group having to submit a group report at the end of the semester (Part A = 50% of the overall grade), together with the code developed during the project (20% of the overall grade). The group report is a maximum of 3,000 words (excluding appendices and references). Each student also submits an individual report of 500 words summarizing their contribution to the group work, their reflections, and possible areas for improvement (Part B = 20% of the overall grade).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should bring their own laptop to the seminar. Practical experience in programming of any language would be advantageous but not a must.

Content:
The aim of this seminar is to introduce students to the fundamentals of Python, a general-purpose programming language widely used in the application of Life Science Analytics and Business Analytics. The seminar will provide the skills for implementing your own algorithms as well as using the thousands of Python packages available for data analysis, modelling, inference, simulation,

prediction, forecasting, visualisation, optimization and decision support. During the seminar, students will be provided ample opportunity to practice their programming skills and obtain formative feedback. The seminar is focused on practical knowledge, examples, and Life Science analysis and business analysis, rather than learning general programming concepts only. The seminar is very much hands-on, with the ultimate goal of turning you into a versatile data analyst for business and life science applications.
Week Topics
1 Introduction and getting started with Python (Colab, github, VScode demonstration)
2 Conditionals and loops, Function, modules and exceptions
3 Object-oriented Programming (class)
4 Shallow vs deep copy, reading of and writing to files, variable number of arguments in functions
5 Numerical analysis I (Numpy)
6 Numerical analysis II (Pandas)
7 Data Exploration and visualization I (Kaggle, Matplotlib)
8 Group Presentation
9 Data Exploration and visualization II (Seaborn and other plot libraries)
10 Data processing and preparation in Python I (missing value handling)
11 Data processing and preparation in Python II
12 Introduction to machine learning with Python I
13 Introduction to machine learning with Python II
14 Introduction to machine learning with Python III
15 Prompt engineering for researchers and marketers

Intended Learning Outcomes:
At the end of the seminar, students are able to:
1. Read and write Python code and understand how to use Python packages.
2. Implement algorithms of moderate complexity in Python.
3. Understand the fundamentals of object-oriented programming using Python.
4. Understand how to implement simple data science and optimisation algorithms from the literature to tackle business and life science applications.
5. Develop their own algorithms to solve basic data science and optimization problems.
6. Use Python packages to solve complex analysis, visualization, and optimisation problems in business and life science.
The learning outcomes of the group work will be improved skills in working as a group, and improved communication and management report writing skills. For the individual presentation, the learning outcomes encompass refined skills in independent research, code development, and presentation techniques. These are practical skills that are transferable to team-focused work in general.

Teaching and Learning Methods:
The seminar each week will be delivered by face-to-face teaching, individual coding and feedback. Every seminar will have meticulously prepared code tasks, which students are required to complete within a specified time. Answers and solutions will be revealed half an hour before the end of the seminar. Note that during the seminar, using generative platforms like ChatGPT

for these tasks is discouraged. Students should rely on internet searches and reading relevant documents to produce workable code solutions. This is very important for beginners learning a programming language. Later on, when students have a more solid foundation in coding, they can use tools like GPT to tackle some more advanced tasks.
Material covered will be made available the week before the seminar. Students are suggested to look at the provided material prior to the seminar to avoid getting lost during the delivery as well as make learning as efficient as possible by asking questions on topics requiring clarity. Learning a programming language and being able to apply it to tackle analytics problems is like learning and using an actual new language. The only way this can be achieved is by sufficient practice.

Media:
Powerpoint, VScode, github, googlecolab

Reading List:
Core texts:

Python manual - https://www.python.org/doc/

A.B. Downey. Think Python: How to Think Like a Computer Scientist. O’Reilly, Media, Inc., 2012.

W. McKinney. Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. O'Reilly Media, Inc., 2012.

S. Guido, A. Müller. Introduction to Machine Learning with Python: A Guide for Data Scientists. O'Reilly Media, 2016.

The seminar draws material from various sources but these three sources provide a nice overview of all the topics covered in the module.

Supplementary Texts:

E. Jones, E. Oliphant, P. Peterson, et al. SciPy: Open Source Scientific Tools for Python. http://www.scipy.org/, 2001-.

C.H. Papadimitriou and K. Steiglitz. Combinatorial optimization: algorithms and complexity. Courier Corporation, 1982.

C. Reeves and J.E. Rowe. Genetic Algorithms: Principles and Perspectives – A Guide to GA Theory. Kluwer Academic Publishers, 2003.

Responsible for Module:
Cabernard, Livia; Prof. Dr.sc. ETH Zürich

Courses (Type of course, Weekly hours per semester), Instructor:
Programming in Python for Business and Life Science Analytics (MGT001437, englisch) (Seminar, 4 SWS)
Shan Y
For further information in this module, please click campus.tum.de or here.

Module Description

WI001205: People in Organizations: Managing Change and Sustainability in Agribusiness and the Food Industry | People in Organizations: Managing Change and Sustainability in Agribusiness and the Food Industry

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The assessment type for the module is a graded report (100%). The report includes memorandums addressing 9-10 of the case studies discussed in class; and a concept paper addressing an organizational concept. The concept paper is also presented by each student. Through the case memorandums, the students demonstrate the ability to discuss the assigned case questions by selecting and applying suitable theoretical concepts to agribusiness and the food industry. Building on the reflection process for each individual memorandum and the cases, which build on each other, deep-level contextual learning is achieved. In the concept paper, students demonstrate their ability to research and critically evaluate a current organizational concept. Through the presentation and discussion of the concept paper, students demonstrate their ability to communicate theoretical concepts and their application to agribusiness and the food industry.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
This is an advanced module. Prior knowledge of economic and management concepts is required. Successful completion of a management course on MSc. level is required, e.g., Human Resource Management in Agriculture and Related Industries or Agribusiness Management. Experience in desk research and scientific writing is required. Knowledge of basic concepts of human resource management and management skills is required.

Content:
The module builds on key concepts of economics and management, specifically human resource management, to provide master level students with knowledge in organizational behavior, theory, and development and build competencies in organizational analysis and change.
Topics covered include:
- metaphors of and perspectives on organizations, their strengths and limitations
- the role of the individual, the group, and the organization in a high performance environment
- organizational structures and the organization-environment fit
- corporate social responsibility, sustainability challenges, business ethics, and ethical conduct in bio-based industries
- adapting to current challenges and changes in the institutional environment of agriculture and the food industry
- understanding organizational change, facilitating change processes, and overcoming barriers in the context of agribusiness and the food industry.

Intended Learning Outcomes:
After successfully completing the module students are able to analyze, evaluate, and change organizational management and development practices in the agribusiness and food industry context. Specifically, students are able to
˜ select and apply suitable theoretical concepts or models of organizational behavior, theory, and development to meet organizational challenges in agribusiness and the food industry
- contrast the strengths and limitations of different perspectives on organizations
- evaluate the potential impacts of various organizational management options on the individual, group, and organizational levels
- identify ethical challenges and options to organizations in agribusiness and the food industry
- adapt organizational practices and policies to sustainability measurement requirements and develop organizational sustainability or CSR (corporate social responsibility) policies
- structure organizational change processes, apply models of organizational change, and evaluate a model’s potential implications
- adapt organizational management and development practices to the specific context in agribusinsess and the food industry.

Teaching and Learning Methods:
The course People in Organizations: Managing Change and Sustainability in Agribusiness and the Food Industry has a seminar format based on the case study method. The seminar format is implemented based on case descriptions of problems, challenges, and innovations in agribusiness and food industry supply chains. Through individual document research and individually prepared class discussions and group work, students develop the ability to critically reflect on and apply concepts of organizational behavior, theory, and development in the context of agribusiness and the food industry. Through presentations and concept discussions, students develop in-depth knowledge of exemplary theoretical concepts. During class discussions and group presentations, students reflect on their experiences, prior knowledge, and assignments to develop their conceptual and evaluative skills and to adapt theoretical knowledge to practical challenges

Media:
Reading assignments; case descriptions; presentation software; discussion facilitation support media, such as flipcharts and discussion boards; video clips and podcasts.

Reading List:
Selected chapters from
Brown, Donald R. (latest edition). An Experiential Approach to Organization Development, Prentice Hall: Boston.
Daft, Richard L. (latest edition). Organizational Theory and Design. South-Western/Cengage Learning.
Kreitner, Robert and Kinicki, Angelo (latest edition). Organizational Behavior. McGraw-Hill Irwin.
Morgan, Gareth 2006. Images of Organization. Updated ed., Sage: Thousand Oaks/CA.

Responsible for Module:
Vera Bitsch bitsch@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1295: Positioning and Navigation for Off-road Vehicles | Positioning and Navigation for Off-road Vehicles [WZ1295]

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
During a written examination (Klausur, 90 min., essays, definitions, numeric problems, creating programs on paper, without use of learning aids) students have to show their ability to explain terms, communication principles, key parameters and properties of positioning and navigation systems for off-road vehicles.
They have to present details of correction methods for satellite navigation systems.
Students have to show their ability to create a feasible navigation system for certain applications. Furthermore they have to create design on given template on examination paper, as well as to explain correction messages and to illustrate quality measures for accuracy.

The written examination contains numerical problems and questions related to programming.
No paper or electronic material is allowed in the written exam session, only a scientific calculator without programming capabilities; graphing calculators are strictly prohibited.

In addition, there is the possibility of providing a voluntary mid-term performance in accordance with APSO §6, 5.
Therefore, students demonstrate in a written report that they are able to present and critically evaluate the handling of data previously learned in the exercises by using their own experimental data and its analysis.
0.3 can improve the module grade by passing the course work, if the overall impression better characterizes the student's performance level and the deviation has no influence on passing the examination.
For the mid-term performance, no repetition date is offered. In the event of a repetition of the module examination, a mid-term performance already achieved will be considered.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Recommended prerequired knowledge involves basic mathematics and basic software development skills.

Content:
In the module, positioning and navigation methods and technologies related to off-road vehicles are studied. The main use case are agricultural vehicles navigating in open fields, but use of the same technologies in other off-road vehicles, like construction machinery are discussed along the course.
The content is:
- system components of positioning and navigation systems
- development milestones of positioning technology
- modern satellite navigation systems
- correction methods for satellite navigation
- protocols and communication standards related to positioning technology
- sensor technologies for positioning beyond satellite navigation
- requirements for autonomous navigation
- future technologies

Intended Learning Outcomes:
After completion of the module, the students are familiar with the key elements of positioning technology and usage of those in conjunction with off-road vehicles, like agricultural vehicles. The applications cover not only navigation and autonomous usage but also precision farming and manipulation of objects in off-road environment. Students gain deep understanding of building a control system consisting of positioning and navigation modules. In addition, they are able to discuss alternative positioning technologies beyond satellite navigation, such as vision and laser distance sensors.
Students are able:
- to describe principles of navigation systems of off-road vehicles
- to describe the system components of off-road vehicles automation
- to create small software to analyze positioning traces and post-process recorded raw data
- to install and adjust corrections signal for satellite navigation systems
- to design system requirements for navigation system in open field off-road vehicles.

Teaching and Learning Methods:
The module contains lectures in which the theoretical principles are learned. After each lecture, an exercise session follows and students are able to learn the topic more hands-on, either by using electronics tools, analyzers, or software development environment. The module may contain field days and small group projects; to be announced in the first lecture.

Media:
To be announced in the first lecture.

Reading List:
Lecture notes. To be announced in the first lecture.

Responsible for Module:
Oksanen, Timo timo.oksanen@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Positioning and navigation for off-road vehicles (Vorlesung, 2 SWS)
Hornburg H, Moll M, Oksanen T, Soitinaho R

Positioning and navigation for off-road vehicles (Übung, 3 SWS)
Hornburg H, Moll M, Soitinaho R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1488: Perspectives of Genetic Engineering in Agriculture | Perspectives of Genetic Engineering in Agriculture

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination of the module is done in the form of a written exam (Klausur, 90 min) and includes methods and challenges of genetic engineering in the context of agriculture. The exam consists of individual exam questions from each lecturer, which require their own corresponding text formulations. The overall grade of the module is calculated from equally weighted individual assessments by the lecturers.

By answering these questions, the students should prove that they are familiar with the diverse methods and challenges of genetic engineering in agriculture and that they are able to comment on the resulting requirements for society, research, nutrition, and food.
It is also checked whether and to what extent they can reproduce and assess the respective new technologies and research results as well as their advantages and disadvantages with regard to the above-mentioned specialization areas.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
A bachelor's degree. Basic principles of genetic engineering.

Content:
Overview of application areas and backgrounds of genetic engineering methods in agriculture: transgenic plants, transgenic livestock, diversity of applied methods, detection methods, biosecurity, horizontal gene transfer, impact on the soil and the environment, safety assessment, official surveillance, and social problems.

Extract from the lecture topics:
Michael Pfaffl: Introduction to Perspectives of Genetic Engineering in Agriculture;
Patrick Bienert: Current general framework conditions and their consequences on genetic engineering approaches in agriculture;
Patrick Gürtler: Official surveillance of genetically modified organisms;
Krzysztof Flisikowski: Fundamentals of genetic engineering in farm animals and application examples;
Benjamin Schusser: ECreation of genetically modified chickens and application examples;
Friederike Ebner: Targeting disease resistance: chances and challenges for genetic engineering to improve livestock health;
Claus Schwechheimer: Examples of the application of genetic engineering in crops;
Michael Schloter: Influence of transgenic plants on soil quality, horizontal gene transfer, stability of DNA in the soil, problem area antibiotic markers
Mohsen Zare: Unleashing the Power of Roots: Multidimensional Perspectives on Root and Rhizosphere Traits for Improving Plant Access to Water and Nutrients under Deficit Conditions;
Ralph Hückelhoven: New methods of genetic engineering of plant disease resistance;
Prof. Johannn Benz: Use of genetic engineering in fungi for the use of plant biomass and agricultural residues in modern biorefineries.

Intended Learning Outcomes:
After the successfully participating in this module, the students are able to focus on the social, technical and global challenges of genetic engineering in agriculture. They will recognize the challenges and opportunities of genetic engineering in various context.
In particular, with regard to the areas of specialization in genetic engineering in the plant sector (with a specialization on crop science), in the animal sector and in the focus on genetic engineering methods, the students can discuss and competently argue which techniques and approaches appear suitable in the future, contributing to the solution of global agricultural problems, and what methods and innovative concepts are being pursued.
In addition, the students are able to evaluate various old and new genetic engineering methods and the GMOs itself generated from them with regard to their effectiveness, biological safety and their advantages and disadvantages.
Furthermore, the students can assess genetic engineering in the context of the worldwide different social acceptance (especially the comparison between Germany, Europe, USA and worldwide).
In addition, the students are able to address research projects presented in the courses and to assess their results against the background of upcoming challenges.

Teaching and Learning Methods:
The subjects mentioned are brought closer to the students in a colorful series of lectures given by experts from the respective agricultural departments. The students are encouraged to discuss selected issues again and again, whereby they should learn to consider different points of view and perspectives, to critically question facts and then to classify them objectively and correctly.
The lectures are mainly given by TUM lecturers, but also by external guest lecturers.

Media:
Lecture series by various lecturers in a multimedia presentation style. All scripts are available via TUM moodle.

Reading List:
GMO @ BFR -- https://www.bfr.bund.de/en/authorisation_of_genetically_modified_food_and_feed-4960.html
GMO Q BVL -- https://www.bvl.bund.de/EN/Tasks/06_Genetic_engineering/genetic_engineering_node.html
GMO @ EFSA -- https://www.efsa.europa.eu/en/topics/topic/gmo
Gesetz zur Regelung der Gentechnik -- https://www.gesetze-im-internet.de/gentg/index.html

Responsible for Module:
Pfaffl, Michael; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2661: Problem Weeds | Problemunkräuter

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 120	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer Projektarbeit erbracht. Die Projektarbeit gliedert sich in eine Recherche, eine Präsentation (15-20 Minuten) und eine schriftliche Aufbereitung in Form eines WIKI-Eintrags zum Einsatz adäquater Methoden der Unkrautkontrolle an dem vorgegebenen Fallbeispiel. Dabei weisen die Studierenden nach, dass sie eigenständig relevante Quellen recherchieren sowie die Biologie von Problemunkräutern beschreiben und ihre wichtigsten Merkmale charakterisieren können. Darauf aufbauend sollen sie Maßnahmen zur Kontrolle von Problemunkräutern mit Blick auf konventionelle, integrierte und biologische Systeme planen und deren Wirksamkeit aus der Literatur bewerten können. Im Vortrag zeigen die Studierenden, dass sie in der Lage sind, die wesentlichen Aspekte ihrer Planungen strukturiert darzustellen sowie dabei gleichzeitig rhetorisch überzeugend aufzutreten. Aus den Abbildungen und Texten des Vortrags wird dann ein Wikipedia-Eintrag für das interne Unkraut-WIKI erzeugt. Die Studenten arbeiten sich dazu in die Wiki-Programmierung ein und strukturieren das Referat als publizierbare Webseite. Im Plenum wird abschließend überprüft, ob der Onlinetext professionell konzipiert ist und im (TUM-internen) Wiki hochgeladen werden kann. Die Gesamtleistung setzt sich aus der Recherche und Powerpoint-Ausarbeitung (30%), dem Vortrag (30%) und der Erstellung des Wikipedia-Eintrags (40%) zusammen.

Repeat Examination:

(Recommended) Prerequisites:
Zum besseren Verständnis der Vorlesung sind Kenntnisse in Pflanzenphysiologie und pflanzliche Systematik erforderlich, Grundwissen über landwirtschaftliche Produktion ist von Nutzen.

Content:
Die Studenten erlangen Einblick in ein wichtiges Arbeitsfeld der angewandten Biologie und schätzen fallweise den Einsatz adäquater Methoden der Unkrautkontrolle ab.

Schwerpunktthemen:
- Biologie der Unkräuter
- Entwicklung verschiedener Herbizidklassen, Wirkorte und Wirkprinzipien
- Methoden der Herbizidverwendung
- Applikationstechnik und die Verwendung von Wirkstoffkombinationen
- Unkrautkontrolle im konventionellen, integrierten und ökologischen System
- Die Rolle von Wiki-Beiträgen zur Information von Stakeholdern

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden das grundlegende theoretische Verständnis und Fachwissen über Unkrautkontrolle und Pflanzenschutz in den wichtigsten Bewirtschaftungsformen (konventionell, konservierend, ökologisch). Dabei sind sie in der Lage,
- Biologie der Unkräuter zu verstehen und Wirkprinzipien von Unkrautkontrollmaßnahmen zu unterscheiden.
- die Prinzipien des Pflanzenschutzes im Integrierten und im Ökologischen Landbau anzuwenden
- Methoden der Herbizidverwendung gegeneinander abwägen, Applikationstechnik beschreiben und die Verwendung von Wirkstoffkombinationen begründen.
- einen Onlineartikel für ein Fach-Wiki zu strukturieren, zu verfassen und zu veröffentlichen.
- Unkrautkontrolle im konventionellen, integrierten und ökologischen System vorschlagen und begründen

Darüber hinaus können die Studierenden den Einsatz von Unkrautkontrollmaßnahmen planen und das im chemischen Pflanzenschutz damit verbundene Risiko bewerten.

Teaching and Learning Methods:
Das Modul besteht aus kurzen Vorlesungsblöcken und den begleitenden studentischen Vorträgen zu den ausgewählten Problemunkräutern aus allen Bewirtschaftungssystemen. Studierende sollen damit zum Studium der Literatur und der weiteren inhaltlichen Auseinandersetzung mit den Themen angeregt werden. Die Relevanz der neutralen Informationsvermittlung über Unkrautkontrollmethoden wird verdeutlicht.
In den Diskussionen nach den Vorträgen werden konkrete Fragestellungen über die Nachhaltigkeit der Unkrautkontrolle und der Umweltverträglichkeit der Maßnahmen beantwortet.
Im Anschluss wandeln die Studenten die Informationen aus ihrem Vortrag in einen Wikipedia-Eintrag um, der im Plenum diskutiert und online editiert wird.
Lernaktivitäten: Selbststudium von Primär- und Sekundärliteratur, Recherche im Internet, Anleitung zu Vortragstechniken und der Erstellung und gemeinsamen kritischen Editierung von WIKI-Beiträgen.

Media:
Präsentation, Skript, web-Seite

Reading List:
Hock, Fedtke, Schmidt (1995) Herbizide. Georg Thieme Verlag Stuttgart;
Zwerger P; Ammon HU. (2002) Unkraut Ökologie und Bekämpfung. Ulmer. Stuttgart;

Martin Hanf (1999) Ackerunkräuter Europas: Mit ihren Keimlingen und Samen. Ulmer, Stuttgart;
Andrew Cobb (2010), Herbicides and Plant Physiology, Chapman and Hall
informative webseite: https://passel.unl.edu/pages/

Responsible for Module:
Schröder, Peter; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Problemunkräuter (Projekt, 2 SWS)
Schröder P [L], Schröder P
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1078: Quality of Food Crops | Quality of Food Crops

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the oral examination (30 min) at the end of the semester the learning outcome is tested using comprehension questions and sample problems. Students demonstrate their ability to understand the biochemical processes of primary and secondary plant metabolites and to evaluate genetic potential, environmental factors and the role of mineral nutrition on the quality of vegetable and agricultural crop products. Furthermore the ability is tested to outline the human sensory evaluation on the analysis of aroma compounds of crops. Use of learning aids during the examination is not allowed.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge in plant production and crop quality.

Content:
Dependence of aroma relevant compounds in crops on genetic potential and environmental conditions during cultivation. Knowledge of special extraction and analysis methods for aroma compounds. Basics of Human Sensory analysis and application for crops. Correlation between analytical and sensory methods. Functions of mineral nutrients (N, K, P, S, Ca, Mg, trace elements) in plant metabolism and their effect on plant composition with respect to internal nutritional and processing properties. Effect of mineral nutrition in relation to other exogenous factors on external quality parameters and plant composition from the primary and secondary metabolism are explained by examples from horticultural and agricultural crops.

Intended Learning Outcomes:
Upon successful completion of this module students are able 1. to evaluate the effects of plant production methods and environmental factors on quality parameters of crops and to analyse these

principles with regard to aroma relevant plant compounds. The specialized knowledge of human sensory evaluation can be applied on the analysis of aroma compounds of crops. 2. to evaluate the function of mineral nutrients for quality relevant properties of food crops and to evaluate the role of mineral nutrition (fertilization) compared to other exogenous factors on the quality of vegetable and agricultural crops (i.e. specifically, potatoes, sugar beet, baking cereals).

Teaching and Learning Methods:
The knowledge will be imparted by lectures and presentations. In addition, students will be encouraged to a discussion of the issues to intensify special topics.

Media:
Presentation, slides, lecture, scriptum

Reading List:
Taiz, L. and Zeiger, E. 2006: Plant Physiology. Belitz, H.D.; Grosch, W.; Schieberle, P. 2009: Food Chemistry. Stone, H. and Sidel, J.L. 1993: Sensory Evaluation Practices. Marschner, H. 1995: Mineral Nutrition of Higher Plants.

Responsible for Module:
von Tucher, Sabine, Dr. agr. sabine.tucher@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Plant mineral nutrition and crop quality (Vorlesung, 1,5 SWS)
von Tucher S

Quality parameters of agricultural crops (Vorlesung, 1 SWS)
von Tucher S

Aroma compounds of vegetal plants (Vorlesung, 1,5 SWS)
von Tucher S [L], von Tucher S
For further information in this module, please click campus.tum.de or here.

Module Description

LS10003: Remote Sensing of Agriculture and Vegetation | Remote Sensing of Agriculture and Vegetation

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module assessment is based on a written report (10 pages - A4 single line excluding references; 70% of grade) in combination with a presentation (15 min; 30% of grade). In the report, the students design a strategy of applying remote sensing to gain insights into improving decision making for solving practical problems (e.g., food security, overuse of agrichemicals, biodiversity) in agricultural and vegetation systems.

The students are examined based on the extent to which they are able to:
- situate the problems and strategy in a relevant context
- describe the start of the art and knowledge gaps in the relevant field
- demonstrate deep understanding on methodology
- break down the strategy into workable tasks
- discuss the strategy critically from interdisciplinary perspectives
- show communicative competence

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in agricultural engineering is an advantage

Content:
Remote sensing provides a versatile tool for earth observation and environmental informatics from varied spatial and temporal scales. This module explores the potential and the future trend of the state-of-the-art remote sensing techniques in facilitating the understanding on as well as decision making in agricultural and vegetation systems. We will discuss the fundamentals of remote sensing science, including but not limited the topics below:

- Biophysical-spectral models (e.g., electromagnetic radiation (EMR), radiative transfer, spectral feature extraction, chlorophyll fluorescence);
- Sensor systems (e.g., satellite, drone) and spectral-radiometric measurements;
- Image processing and pattern recognition (e.g., classification, time-series)
- Applications in agriculture and ecology (e.g., crop stress, productivity and biodiversity monitoring)

Through integrated exercise, the students will learn about innovative methods of remote sensing and the use of remote sensing in interdisciplinary fields of agricultural and environmental sciences.

Intended Learning Outcomes:
Upon successful completion of this module, students are able to:
- Understand the important aspects of remote sensing;
- Relate the technologies to research questions and practical problems in other disciplines;
- Apply innovative concepts and methods to agricultural and vegetation systems;
- Evaluate the feasibility of remote sensing from the perspectives of agriculture and ecology;
- Develop a strategy of integrating remote sensing with domain knowledge for decision making in agricultural and vegetation systems;
- Communicate their strategy with good understanding and evidence.

Teaching and Learning Methods:
- This module combines lectures, guest seminars, field trips and computer exercises.
- The teaching content will be organized by topics instructed in both theoretical (e.g., seminar) and practical ways (e.g., hands-on demonstrations, computer programing).
- The students will learn the important concepts and methods of remote sensing, as well as the applications in addressing environmental and societal problems, in a highly interactive manner, e.g., discussion in seminars, collaborations in exercises.

Media:
- Present and virtual lectures
- PowerPoint, instruction manuals, scripts and codes;
- Field and lab hands-on demonstrations;

Reading List:
Literature will be provided according to individual topics and events.

Responsible for Module:
Yu, Kang; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Remote Sensing of Agriculture and Vegetation (Vorlesung mit integrierten Übungen, 4 SWS)
Yu K [L], Yu K, Belwalkar A, Li D, Bai D
For further information in this module, please click campus.tum.de or here.

Module Description

LS10004: Research Project ‘Smart Agriculture’ | Research Project ‘Smart Agriculture’

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module assessment is based on a report (15 pages – A4 single line excluding references; 70% of grade) in combination with a presentation (15 min; 30% of grade). The students usually hand in the report and do the oral presentation in 4 weeks after the practical work has been concluded.

The grade of the written report is based on:
1) the description of the theoretical background, research questions and objectives of the project (20%);
2) the proper description and use of methods, including statistical analysis (20%);
3) the accuracy and correctness of the results, results interpretation and discussion (30%);
4) the quality of presentation formats (e.g., tables, figures) (10%);
5) the overall structure and quality (20%), particularly examines whether the report is situated and summarized in a concise and coherent manner, in the relevant context of the research area.

The grade of the oral presentation is based on:
1) The explanation of the background, state of the art, research questions/ hypothesis (30%)
2) The accuracy and correctness of methods, data and results interpretation (40%)
3) The relevance and rigor of discussion (20%)
4) The presentation quality and skills, e.g., powerpoint format and clarity (10%)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
It is recommend to take the course ‘Remote Sensing of Agriculture and Vegetation’

Basic knowledge in plant and soil sciences, agricultural engineering and remote sensing is an advantage
Basic programing skills (e.g., R, Matlab, Python) will be an big advantage

Content:
Smart Agriculture or precision agriculture is considered as a high-tech and interdisciplinary field. Students will learn how to apply and combine multidisciplinary technologies, including but not limited to, field survey, lab biochemical analysis, phenotyping, remote sensing, image analysis and AI techniques to characterize plant traits and their responses to the environment and stresses (e.g., drought). Through specific research questions and objectives, students will explore the potential and limitations of applying the new technologies to solve practical problems, e.g., in the following categories:

- Using unmanned aerial vehicles (UAV) based images (e.g., RGB, multispectral) for high throughput analysis of crop traits (e.g., height, chlorophyll), and for yield estimation and weed detection.
- Using satellite remote sensing images to monitor the spatiotemporal variability in crop health (e.g., nitrogen, water status), biomass and yield in response to environmental and climate changes.
- Correlating leaf and plant optical properties to stresses (e.g., drought) and explaining plant phenotypic and genotypic variations with the aid of hyperspectral data and radiative transfer models.
- Mapping soil spatial variability based on proximal- and remote sensing of soil physical and chemical properties using hyperspectral and multispectral data.
- Applying machine learning (ML) and deep learning (DL) to analyze satellite remote sensing data for crop type and area mapping;
- Applying ML and DL methods to analyze plant images (e.g., UAV) to detect specific objects (e.g., flowers, wheat ears) as a proxy of seed germination, plant health, productivity and biodiversity.

Intended Learning Outcomes:
Upon successful completion of this module, students will be able to:
- understand the theoretical background knowledge related to smart agriculture;
- define research questions for their selected topics in the related research area;
- apply sensor and imaging techniques for data collection in the field and laboratory;
- acquire computational and artificial intelligence (AI) skills for big data handling and data evaluation;
- interpret the results of statistical analysis and machine learning models;
- present the research findings in a concise manner in written and oral form;
- gain competence in applying proximal- and remote sensing, and AI technologies in precision agriculture.

Teaching and Learning Methods:
- The students conduct a semester (normally three months) research project. The schedule of field or lab work can be adjusted according to the student’s curriculum.

- Three to five students team up as a group and define the research topic and proposal through discussion with the lecturer.
- The lecturer teach students through theoretical (e.g., seminar) and practical instructions (e.g., hands-on demonstrations, computer exercises).
- Students conduct the project through teamwork (3-5) and collaborations with doctoral students.
- Periodic meeting with the supervisor to discuss the progress of project.
- Journal club discussing related scientific articles with the lecturer and peers.
- Seminars to present project output and exchange with fellow students.

Media:
- PowerPoint, instruction manuals, scripts and codes;
- Field and lab hands-on demonstrations;
- TUM-Moodle, Zoom

Reading List:
Literature will be provided according to individual projects.

Responsible for Module:
Yu, Kang; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project 'Smart Agriculture' (Projekt, 10 SWS)
Yu K [L], Hu Y (Wu F), Afrasiabian Y, Yu K (Wang J)
For further information in this module, please click campus.tum.de or here.

Module Description

LS10049: Research Project Soil-Plant-Atmosphere Continuum | Research Project Soil-Plant-Atmosphere Continuum

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The learning outcomes of this module will be assessed through two main components: a written report and an oral presentation. These assessment methods are chosen to reflect the students' ability to both critically analyze and present scientific findings, which aligns with the key skills developed throughout the course.
• Written Report (70% of total grade):
The primary assessment will be a scientific report, approximately 20 pages in length. This report will evaluate the experimental results obtained during the lab work, demonstrating the student's understanding of the research question, methodology, and data analysis. In addition, the report will require students to connect their findings to relevant scientific literature, illustrating their ability to engage with current research and place their results within the broader scientific context.
• Oral Presentation (30% of total grade):
In addition to the written report, students will give a 20-minute oral presentation to the public at the chair of Soil Biophysics and Environmental Systems, summarizing their research project and discussing their results. This will be followed by a short Q&A session where students will demonstrate their ability to defend their findings and discuss their relevance to the field.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of Soil Science is encouraged (this content is taught in modules WZ1825 Soil Science, LS10031 Experimental Methods in Soil Physics or LS20022 Experimental Methods in Soil and Plant Hydrology, for example).

Content:
This module introduces students to current topics and experimental methodologies related to soil-plant-atmosphere interactions, with a particular focus on water and carbon flux dynamics. The specific research project for each student is tailored according to the ongoing research within the group and the student's individual interests.
Typical topics covered in the module include:
• Soil-plant hydraulic dynamics and their role in water transport within ecosystems
• Carbon allocation processes within plants and soils, emphasizing storage and movement of carbon
• Root exudation and its impact on soil microbial communities and nutrient cycling
• Effects of drought and heat stress on soil health and plant physiological responses
• Soil amendments and their role in enhancing soil fertility and structure
• Regenerative farming techniques aimed at improving soil and ecosystem resilience
• Soil contamination and remediation, exploring approaches to mitigate and repair environmental damage
• Root anatomy and morphology and their influence on plant performance and soil interaction
• Root-mycorrhizae interactions and their contribution to nutrient uptake and plant health
• Rhizosphere development and the complex interactions between roots, soil, and microorganisms
• Soil hydrophobicity and its implications for water infiltration and retention
Students will gain hands-on experience with a variety of standard soil and plant physiology techniques. In addition, students will be introduced to data analysis tools commonly used in research, such as R, Python, and MATLAB, to handle and interpret experimental results.
A list of current projects is available at https://www.lss.ls.tum.de/sbe/offered-projects-theses-positions/, and students are encouraged to propose their own topics within the group’s research focus.

Intended Learning Outcomes:
Upon successful completion of this module, students will have acquired the following knowledge and skills:
• Comprehensive understanding of current challenges in research related to soil-plant-atmosphere interactions.
• Practical proficiency in advanced methodologies for investigating the dynamics within the soil-plant-atmosphere continuum.
• Ability to design, execute, and critically evaluate research studies, drawing connections between experimental results and existing scientific literature.
• Competence in effectively communicating research findings through both oral presentations and written reports, tailored for a scientific audience.
• Apply cutting-edge techniques in soil and plant ecology to solve complex, research-driven questions within the soil-plant-atmosphere system.

Teaching and Learning Methods:
This module combines practical laboratory work with theoretical instruction to ensure students achieve the learning outcomes effectively.
Practical Laboratory Work:

• Each student will work on an ongoing research project within the group, supervised by a dedicated scientist. The hands-on nature of this method allows students to directly apply the theoretical knowledge gained, reinforcing their understanding of experimental techniques and scientific processes. All laboratory work will be conducted under the guidance of experienced lab staff, using written laboratory protocols or technical literature provided to students. This ensures accuracy, safety, and the ability to follow established research methodologies.
Theoretical Instruction:
• Students will receive introductory briefings that lay the foundation for understanding the key concepts and methodologies central to the soil-plant-atmosphere continuum. These briefings ensure students have the necessary background before commencing their practical work. Throughout the project, students will engage in ongoing discussions with their supervising scientist, allowing them to continuously deepen their theoretical knowledge and critically reflect on their experimental results in the context of the current scientific literature.
Independent Research and Literature Review:
• Students will be encouraged to research current literature independently, supplementing their practical work with cutting-edge scientific findings. By synthesizing theoretical knowledge from research articles, students will develop a deeper understanding of their topic, cultivate critical thinking skills, and gain insights into the broader scientific context of their work.
Presentation and Communication:
• At the end of the module, students will be required to present their research findings both orally and in written form. This task is essential to develop communication skills, as students must articulate their methodologies, results, and interpretations clearly and professionally, just as they would in a scientific setting. It also reinforces the learning outcome related to effectively communicating complex scientific data to an audience.

Media:
Pdfs of lab methods, scientific papers, and whiteboard writing shared through TUMmoodle and/or Teams group chat.

Reading List:
Environmental Soil Physics (D Hillel)
Water Relations of Plants and Soils (PJ Kramer, JS Boyer)
Experimentelle Pflanzenökologie – Grundlagen und Anwendungen (R Matyssek, WB Herppich)

Responsible for Module:
Zare, Mohsen, Prof. Dr. (mohsen.zare@tum.de) Hafner, Benjamin, Dr. rer. silv. (benjamin.hafner@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project Soil-Plant-Atmosphere Continuum (Projekt, 10 SWS)
Zare M [L], Zare M, Hafner B
For further information in this module, please click campus.tum.de or here.

Module Description

LS20016: Rhizosphere Research | Rhizosphere Research

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
This module is graded, and students are asked to give a seminar presentation complemented by the submission of an extended summary on a selected topic to demonstrate a solid understanding of topics discussed in the lectures. The oral presentation is expected to be 15 min presentation followed by a subsequent 30 min discussion to demonstrate that he or she is able to respond competently to any questions, suggestions, or discussions brought by the audience and relating to his or her subject area. The extended summary is expected to be a minimum of 5 pages and will be graded. Students will be informed about the grading criteria of their extended summary during the lecture via a template. The presentation will be scheduled within the last three weeks of the semester. The extended summary should be submitted by the end of the semester.

In addition, there is the option of taking a voluntary mid-term assignment as coursework in accordance with APSO §6, 5. For this, an oral examination (30 min) has to be given. The oral exam targets the learning outcomes of the lecture of Soil Biophysics. The module grade can be improved by 0.3 by passing the course work if this better characterizes the student's performance level based on the overall impression and the deviation has no influence on passing the examination. No repeat date is offered for the mid-term performance. Successfully passed mid-term assignments will be considered when retaking a failed module examination at the next possible examination date.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The scope of this module is to learn fundamental biophysical processes taking place at the root zone and particularly at the root-soil interface and their emerging impacts on water and nutrient exchange between the soil-plant-atmosphere continuum. In this module, we will discuss the basic principles of soil physics in the context of water and nutrient transport within soils and plant roots. The particular attention is to learn why, when, and where soil physics plays an important role in water and nutrient transport across the soil-plant-atmosphere continuum.

Intended Learning Outcomes:
This module aims to enable students:
1) To mechanistically describe the theories of water and nutrients retention and transport across the soil-plant-atmosphere continuum
2) To mechanistically discuss why and when plant access to soil resources is limited in different soils and how plants may deal with these limitations
3) To evaluate the potential roles of different belowground traits (soil and plants) in improving plant access to limited soil resources under different conditions
4) To explore the state-of-the-art search in the field of soil-plant interactions and rhizosphere

Teaching and Learning Methods:
This module consists of two parts:
1) Lecture on Soil Biophysics: In weekly lectures, students will be introduced to the principle of water and nutrient transport within porose media, such as the soils-plants-atmosphere continuum. We will first begin by introducing students to the fundamental principle of the following key physical processes in soils: water retention in soil, water potential (freedom) in soils, the flow of water within soils, infiltration, evaporation, transpiration, root water uptake, and solute transport within soils. Then we will continue by focusing on the feedback between soil and plants and soil and microorganisms. Students will learn how biota's life (plants and microorganisms) may impact soil's physical properties and how the physical properties of soil may impact the emergence of life in soils.

2) Seminar on New emerging topics in Soil Biophysics: This seminar aims to discuss the fundamental biophysical and biochemical processes taking place across the soil-root interface and their emerging impacts on water, nutrient, and carbon flux across the soil-plant-atmosphere continuum. Students will be briefly introduced to some selected state-of-the-art topics and will be asked to perform a deep literature review and present their findings in the form of an oral presentation and an extended summary at the end of the semester.

Media:

Reading List:

Responsible for Module:
Zare, Mohsen, Prof. Dr. mohsen.zare@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
New emerging topics in Soil Biophysics (Seminar, 2 SWS)
Hafner B, Zare M

Soil Biophysics (Vorlesung, 2 SWS)
Zare M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1339: Robotics and Automation in Agriculture | Robotics and Automation in Agriculture

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
One written exam at the end of the semester. During written examination (Klausur, 60 min., essays, definitions, without use of learning aids, in English) students have to show their ability to explain terms and core technologies in agricultural robotics. They shall be able to describe important components of agricultural automation processes. The students have to be able to summarize key principles and the common technologies used in robotics and automation in modern agriculture. The content of the exam will include not only material from the lectures but also the reading materials. No paper or electronic material is allowed in the written exam.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
There are no prerequisites.

Content:
In addition to the academic element of the course, students will also benefit from an excursion day to a nearby manufacturer. In addition, one of the lectures will be a guest lecture from industrial partners.

The course covers the key components of robotics and automation technologies in modern agriculture. The course is split into 4 parts:
• Sensing & Imaging
• Dynamics & control
• Communications
• Guest Lecture and case studies — an opportunity to review the technologies presented in the course in a given situation

Intended Learning Outcomes:
After completing the module, students will be familiar with the common technologies that are used in robotics and automation in modern agriculture. Furthermore, students will be able to:
- Describe key principles of agricultural robotics.
- Understand key vision/sensing technologies in agri-robotics
- Compare different sensing technologies such as cameras, LIDAR's, and radars.
- Understand the control elements of automation.
- Apply their knowledge and be able to give recommendations for three different case studies and applications (Robotic milking, irrigation & orchard management, and forestry control).
- Evaluate the suitability of different technologies for various situations and give convincing reasons.

Teaching and Learning Methods:
Teaching method is class lecture to directly transfer the theoretical knowledge. Furthermore, the class lecture gives the opportunity to discuss the learning results in an interactive way. In addition, one excursion is planned to demonstrate some practical applications of the provided module content.

The module consists of weekly lectures (90 min.) and one excursion during the semester, date of which will be organized together with students. Slides and supplementary material are used to transfer the content. Lecture slides and notes will be regularly uploaded in Moodle.

Media:
PowerPoint lecture slides will be uploaded in TUM-Moodle.

Reading List:
Recommendations for reading will be announced in the first lecture.

The course follows recent scientific advances in the field, such as:
Soitinaho, Riikka; Moll, Marcel; Oksanen, Timo: 2D LiDAR based object detection and tracking on a moving vehicle. IFAC-PapersOnLine 55 (32), 2022, 66-71
Brodie, Samuel; Oksanen, Timo: Introducing Metrics to Analyse the Performance of Automatic Section Control for Agricultural Machines. IFAC-PapersOnLine 55 (32), 2022, 229-234

Responsible for Module:
Oksanen, Timo; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Robotics and Automation in Agriculture (Vorlesung, 2 SWS)
Oksanen T [L], Brodie S, Hefele R, Moll M, Oksanen T, Pindl L, Soitinaho R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1549: Research Project 'Plant Nutrition' | Research Project 'Plant Nutrition'

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination of the module is done in the form of a research paper and includes a written lab / project report of about 3000 words / 20 pages and a presentation (30 min).
The final grade is an averaged grade from the written lab report (75 %) and from the presentation (25 %).

The learning outcome is tested by a graded project report (75%). Students show that they are able to introduce (state-of-the-art, hypothesis, research question), record, structure, analyze, evaluate, and summarize their research work and that they can conclude on the achieved results from the experiments and analyses. In the report they show that they can relate background knowledge, e.g. reactions of plants to abiotic stress, to the own performed research in the lab. They show how the specific methods are applied, critically evaluate the suitability of the methods, present results in a structured way in relation to the research question, discuss their results with respect to the present state-of-the art knowledge and formulate perspectives.
The students demonstrate with the report to have gained deeper knowledge on employed methods and on the investigated research topic.
The project report will be complemented by a graded oral presentation (25%) in which students show their communication competency in presenting their scientific work and project to a scientific audience. The students are expected to present (about 20 min) and discuss (about 10 min) their research results according to scientific standards.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge in (molecular) plant nutrition and plant physiology

Content:
Current research topics in molecular plant nutrition e.g., plant responses to abiotic stress (nutrient deficiency, nutrient toxicity, drought, salinity, heat, changing wheather extremes), nutrient efficiency mechanisms, nutrient transport in the plant and in the substrate/soil, and nutrient turnover and losses to the environment.
Studies focus on specific experimental and methodological skills employed in current plant nutritional approaches in order to investigate and understand yield formation, root system architecture development, nutrient acquisition and nutrient translocation at the cellular and the whole plant level, as well as the nutrient- and/or water status of plants.

Intended Learning Outcomes:
At the end of the module students will be able to:

- apply theoretical background knowledge on the selected research area in plant nutrition (e.g. molecular, biochemical, morphological or physiological causes and consequences of abiotic stress such as nutrient deficiency or nutrient toxicity to plants, challenges in nutrient efficiency and in nutrient losses to the environment);
- judge on plant cultivation growth set-ups suitable to phenotype and evaluate root- and shoot growth and development under nutrient limiting conditions;
- operate up-to-date and modern techniques ranging from molecular biological to classical plant nutritional techniques (methodological competencies) to understand the nutritional status of (crop) plants as well as their response reactions to deficient or toxic nutrient levels;
- assess open questions related to crop growth and health using molecular, physiological, and analytical methods;
- execute specific and appropriate methods for data acquisition in the selected research area (e.g., molecular biological and chemical analyses, non-destructive or minimal-invasive imaging techniques);
- apply specific techniques of data analysis (e.g., specific statistical evaluation methods, phenotyping and architecture analysis software);
- develop critical thinking ability for experimental approaches understanding current challenges in plant nutrition;
- evaluate the achieved results with respect to suitability of different current and developing analytical research methods;
- structure achieved knowledge and results for a written report and an oral presentation;
- present their work to an audience and defend their results in a scientific discussion after the oral discussion;

Teaching and Learning Methods:
In the laboratory course students will be supervised and trained individually or in small groups to practically use specific methods of plant nutrition (by e.g. molecular, chemical, biochemical, physiological analyses, imaging techniques, plant growth cultivation techniques, statistical evaluation methods, etc.). Thereby, they will achieve basic hands-on experiences in molecular plant nutritional and crop physiological skills to solve subsequently own-defined open questions

in plant nutrition. Students will get the chance to self-dependently test current and developing methods so that they become able to evaluate their suitability.
The module also includes the individual search on current literature, a training in the generation of a research report and a training in presentation techniques.

Media:
Presentations (e.g., PowerPoint), scripts, instruction manuals, whiteboard work, data analysis software (e.g., EXCEL), Zoom, lab-book, TUM-Moodle

Reading List:
-Marschner, H., 1995: Mineral Nutrition of Higher Plants, Academic Press London, 2nd Edition.
-Marschner, P. (ed) 2012: Marschner's Mineral of Higher Plants, Academic Press London, 3rd Edition
-Journal articles
-Topical and up-to-date Journal reviews (provided by the supervisor)

Responsible for Module:
Bienert, Gerd Patrick, Prof. Dr. patrick.bienert@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project Plant Nutrition (Praktikum, 10 SWS)
Bienert G, von Tucher S, Alcock T, Chen X
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1908: Regulatory Affairs on Food, Cosmetics, Toys, Food Contact Material and Feed, Tobacco Products as well Comparable Products | Recht der Lebensmittel, Kosmetika, Bedarfsgegenstände und Lebensmittelkontaktmaterialien, Futtermittel, Tabakerzeugnisse sowie hiervon berührte Rechtsbereiche

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60 (bei 3 Studierenden, sonst mind. 20 min pro Prüfling).
Die Modulprüfung besteht aus einer mündlichen Prüfung, in der die Studierenden nachweisen sollen, dass sie alle wesentlichen horizontalen und vertikalen Rechtsvorschriften im Lebensmittel- und Futtermittelbereich beherrschen. Als Hilfsmittel können nach Maßgabe des Prüfers die entsprechenden Gesetzestexte hinzugezogen werden. Studierende sollen unter Prüfungsbedingungen ihre rechtliche Einschätzung zu Produkten bzw. deren Kennzeichnung entwickeln, strukturiert darstellen und gegenüber dem Prüfer in der Diskussion verteidigen.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
keine

Content:
Es wird das europäische und nationale Recht der Lebensmittel, Kosmetika, Bedarfsgegenstände und Lebensmittelkontaktmaterialien, Futtermittel, Tabakerzeugnisse sowie hiervon berührte Rechtsbereiche behandelt und an Hand von aktueller Verwaltungspraxis und Rechtsprechung praxisorientiert vertieft.

Themen sind insbesondere:
-- Nationales und europäisches Lebensmittelrecht (BasisVO, LFGB)
-- Lebensmittelkennzeichnung und Täuschungsschutz

-- Health Claims
-- Anreicherung von Lebensmitteln, Food for Specific Groups (Verordnung 609/2013)
-- Abgrenzung zu Arzneimitteln
-- Lebensmittelsicherheit, Hygiene, QMS
-- Spezifische Rechtsvorschriften, wie FIAP (Zusatzstoffe, Aromen, Enzyme), GMO (Gentechnik), Novel Food, ÖkoVO
-- Recht der Kosmetika, Bedarfsgegenstände und Lebensmittelkontaktmaterialien
-- Tabakerzeugnisse
-- Futtermittel
-- sowie hiervon berührte Rechtsbereiche
-- Organisation der Lebensmittelüberwachung, Ordnungswidrigkeiten- und Strafrecht

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, die Kennzeichnung von Lebensmitteln vor dem Hintergrund aller relevanten horizontalen und vertikalen Rechtsgebiete zu analysieren und rechtlich zu bewerten. Sie verstehen die Einstufung und Abgrenzung insbesondere von Lebensmitteln und können dies auf aktuelle Fragestellungen anwenden. Sie haben Kenntnisse über die rechtlichen Besonderheiten spezieller Lebensmittelgruppen, sowie von Kosmetika, Bedarfsgegenständen und Lebensmittelkontaktmaterialien, Tabakerzeugnissen und Futtermitteln und wissen diese in der Praxis anzuwenden. Sie verstehen die Organisation der Lebensmittelüberwachung in Bayern, Deutschland und der EU, sowie die sich aus ordnungswidrigen oder strafbewehrtem Verhalten ergebenden Konsequenzen.

Teaching and Learning Methods:
Das Modul besteht aus zwei Vorlesungen. Die Inhalte der Vorlesungen werden im Vortrag und durch Präsentationen vermittelt. Studierende sollen zum Studium der die Vorlesung begleitenden, ausgegebenen Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt werden.

Media:
Tafelanschrieb, downloadbare Präsentationen

Reading List:
-- Meyer: Lebensmittelrecht; 5. Auflage, dtv-Verlag; ISBN 978-3-423-05766-0
-- Meyer, Reinhart: Lebensmittelinformationsverordnung; 1. Auflage, Eigenverlag; ISBN: 978-3-00-044963-5

Responsible for Module:
Meyer, Alfred Hagen; Prof. Dr. jur.

Courses (Type of course, Weekly hours per semester), Instructor:
Lebensmittel- und Futtermittelrecht (FPO 2021) (Vorlesung, 4 SWS)
Meyer A [L], Meyer A

For further information in this module, please click campus.tum.de or here.

Module Description

LS50035: Current Topics in Equine Science | Spezielle Themen der Pferdewissenschaften

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung des Moduls wird in Form einer Präsentation (20 min) ergänzt durch eine anschließende Diskussion (20 min) erb racht.
In der Prüfung weisen die Studierenden nach, dass sie eine aktuelle Fragestellung aus den Pferdewissenschaften wissenschaftlich basiert in eine strukturierte Präsentation zusammenstellen können und dabei ihre Kenntnisse der Anatomie, der Physiologie, der Ernährung, des Verhalten, der Gesundheit, der Zucht, der Haltung und der Nutzung zur Beurteilung von Fragestellungen und deren Studiendesign und Methodik in den Pferdewissenschaften in folgerichtigen Argumentationsketten nutzen können. Dabei sollen Sie zeigen, dass sie die Bedeutung und Relevanz für verschiedene Zielgruppen kritisch beurteilen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreicher Abschluss des Moduls Pferdewissenschaften im Bachelorstudiengang Agrar- und Gartenbauwissenschaften (agrarwissenschaftliche Orientierung) der TUM oder äquivalentes Vorwissen.

Content:
Ausgewählte kontrovers diskutierte Aspekte aus den Themenbereichen der Pferdeernährung (Verdauungsphysiologie, Futtermittelzusammensetzung und -qualität, Versorgungsempfehlungen, Rationsberechnungen, Charakterisierung von Leistung, Futtermittelzusätze, Ernährung bei Erkankungen),
Pferdegesundheit (Pferdekrankheiten und -prävention, Parasitenkontrolle, Impfempfehlungen für den Einsatz im Sport),
Pferdezucht,

Pferdehaltung und Management (Tierschutzstandards, Stallbau und -management, Weidepflege und -management, Hufpflege und Hufgesundheit),
Ethologie des Pferdeverhaltens,
Pferdesport und -training (Leistungsphysiologie von Sportpferden, Merkmale eines idealen Reitpferdes, Verletzungsprävention im Pferdesport im Kontext von Schutzzielen, insbesondere dem Tier-, Verbraucher-, Umwelt- und Arbeitsschutz.

Intended Learning Outcomes:
Die Studierenden sind in der Lage, Fragestellungen in dem Gebiet der Pferdewissenschaften auf Basis internationaler wissenschaftlicher Literatur zu beschreiben. Sie können wissenschaftliche Studien zur Pferdeernährung, -gesundheit, -zucht und des Tierverhaltens zielorientiert zusammenstellen. Sie sind in der Lage Studien aus dem Bereich der Pferdewissenschaften methodisch und kritisch zu bewerten. Die Studierenden können ihre Ergebnisse logisch strukturiert präsentieren und unter Gewichtung von Stakeholder-Interessen differenziert diskutieren. Desweiteren sollen sie Forschungslücken konkret identifizieren und potenzielle Projekte zur Klärung dieser Fragen vorschlagen können.

Teaching and Learning Methods:
Das Modul findet als präsentationsgestützte Lehrveranstaltungen mit integrierten Übungsanteilen statt und beinhaltet auch den Zugang zu überregionalen wissenschaftlichen Vortragsveranstaltungen in den Pferdewissenschaften. Fremdvorträge, sowie ausgewählte Publikationen (Peer-Reviewed) werden in den oben beschriebenen Themengebieten der Pferdewissenschaften Studiendesign, Methodik und die Ergebnisse kritisch beurteilt und die Ableitung von Empfehlungen für die Praxis aus Sicht verschiedener Stakeholder diskutiert.

Media:
PowerPoint Präsentationen, Skript, Hand-out wissenschaftlicher Fachartikel.

Reading List:
Gesellschaft für Ernährungsphysiologie: Empfehlungen zur Energie- und Nährstoffversorgung von Pferdensorgungsempfehlungen für Pferde 2014

Responsible for Module:
Steinhoff-Wagner, Julia, Prof. Dr.sc.agr. jsw@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Spezielle Themen der Pferdewissenschaften (Vorlesung mit integrierten Übungen, 4 SWS)
Steinhoff-Wagner J, Wein S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1921: Strategy, Supply Chain Management, and Sustainability in Agribusiness and the Food Industry | Strategy, Supply Chain Management, and Sustainability in Agribusiness and the Food Industry

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The assessment type for the module is a graded learning portfolio (100%). The portfolio includes memorandums addressing 9-10 of the case studies discussed in class; and a learning statement addressing conceptual, scientific and personal learning. Through the case memorandums, the students show the ability to discuss the assigned case questions by selecting and applying suitable theoretical concepts to supply chain management and sustainability challenges in the specific context of agribusiness and the food industry. In the learning statement, students demonstrate the ability to reflect on the semester long learning process and summarize the insights gained.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Solid economic and management background; knowledge of basic concepts of strategic analysis, planning, and management (e.g., industry analysis, horizontal and vertical coordination, and SWOT), as well as the ability to apply these concepts; furthermore, knowledge of value chain management is required (e.g., theoretical background, supply chain dynamics, actors and partnerships, governance). Successful completion of a management course on M.Sc. level required, e.g., agribusiness management or value chain management. Medium level experience in desk research and scientific writing is required.

Content:
The module builds on key concepts of supply chain management, strategy, and sustainability to provide master level students with the competency to evaluate pertinent issues in agribusiness and food industry supply chains.
Topics covered include:

- value propositions, creating and capturing added value in agribusiness and the food industry
- management of customers, suppliers, and other stakeholders
- innovation in supply chains, sustainability as an innovation, sustainable supply chains
- CSR (corporate social responsibility) and sustainability measurement
- implementation of a sustainability strategy, as well as costs and benefits of sustainable practices in agribusiness and the food industry
- ethical issues in supply chain management.

Intended Learning Outcomes:
After successfully completing of the module, students are able to evaluate processes of supply chains management in agribusiness and the food industry.
Specifically, students are able to
- evaluate value propositions, as well as plans for creating and capturing value
- evaluate the management of customers, suppliers, and other stakeholders
- independently choose scientific models or concepts relevant to the analysis process of agricultural and food industry supply chains and justify their choice
- evaluate the implementation of a CSR concept or sustainability strategy, and monitor its effects on operations, suppliers, associates, and customers
- identify and analyze ethical issues in supply chain management and to recommend how to apply ethical practices.

Teaching and Learning Methods:
The course Strategy, Supply Chain Management, and Sustainability in Agribusiness and the Food Industry has a seminar format based on the case study method. The seminar format is implemented based on case descriptions of problems, challenges, and innovations in agribusiness and food industry supply chains. Through individually prepared class discussions and group work, students develop the ability to critically reflect and apply concepts of strategy, supply and value chain management, and sustainability requirements in the context of agribusiness and the food industry. During class discussions and group presentations, students reflect on their experiences, prior knowledge, and assignments to develop an in-depth understanding of current challenges in supply chains and how to address the.

Media:
Reading assignments; case descriptions; presentation software; discussion facilitation support media, such as flipcharts and discussion boards; video clips and podcasts.

Reading List:
Current articles from scientific journals as appropriate.
Selected chapters from
Bouchery, Corbett, Fransoo, and Tan (2017): Sustainable Supply Chains: A Research-Based Textbook on Operations and Strategy. Springer: Berlin, Heidelberg, Germany.
Pullmann and Wu (2011): Food Supply Chain Management: Economic, Social and Environmental Perspectives. Routledge, New York, US.

Responsible for Module:
Bitsch, Vera; Prof. Dr. Dr. h.c.

Courses (Type of course, Weekly hours per semester), Instructor:
Strategy, Supply Chain Management, and Sustainability in Agribusiness and the Food Industry (WZ1921, englisch) (Seminar, 4 SWS)
Bitsch V [L], Bitsch V, Owsianowski J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1309: Tractor Engineering Fundamentals | Tractor Engineering Fundamentals

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In a written examination (Klausur, 90 min, in English), the students have to answer multiple questions in written form. The students have to show their ability to understand development process of tractors, including their main components. The students have to be able to describe technical requirements for
tractors, in relationship to mobile machinery. In addition, the students have to show their ability to solve basic problems in designing tractor details, utilizing given fundamental equations and diagrams, using pen, paper and simple calculator. The questions test terminology, capabilities to explain diagrams and graphical data, describe the design principles and solve small engineering problems requiring mathematical skills. No paper or electronic material is allowed in the written examination, only a scientific calculator without programming capabilities; graphing calculators are strictly prohibited.

In addition, there is the possibility of providing a voluntary mid-term performance in accordance with APSO §6, 5.
Therefore, students demonstrate in a written report that they are able to present and critically evaluate the handling of data previously learned in the exercises by using their own experimental data and its analysis.
0,3 can improve the module grade by passing the course work, if the overall impression better characterizes the student's performance level and the deviation has no influence on passing the examination.
For the mid-term performance, no repetition date is offered. In the event of a repetition of the module examination, a mid-term performance already achieved will be considered.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The lecture gives a broad insight into the design fundamentals of modern tractors and emphasizes a high practical relevance. It deals with the historical development in tractor construction and shows functions and application limits of the machines. Both the overall concept and the individual components are covered. Economical aspects are discused, general principles of product planning and project management are presented by using tractors as an example. The outer and inner mechanics of the whole vehicle are explained and the gear concepts including their design/ dimensioning are dealt with. The design of typical drive elements, aspects between human beings and machinery (environmental factors, basics of industrial medicine, noise reduction) and the basics of tractor hydraulics including methods of industrial tests are explained and their use is shown by giving examples.
Theoretical engineering fundamentals (e.g. gearbox calculations, tyre selection, steering geometry, power and traction requirements and ergonomic design principles for the driver) are applied in exercises, by calculation with formulas and equations with provided data sets.

Intended Learning Outcomes:
After participating in the module courses, students are able
- to understand the tractor environment and market and know the development process of tractors.
- to analyse individual components such as diesel engines, transmissions and axles, brakes and hydraulic systems and to demonstrate their functionality.
- to describe the requirements for technical solutions for tractors, which arise due to the special relationship in professional mobile machinery.
- to adapt on the basic principles of integrity of operation, ergonomics and process control for tractors.
- to solve basic problems in designing tractor details using known mathematical and physical models.

Teaching and Learning Methods:
In the lecture, the teaching content is conveyed by means of lecture, presentation and sketches on the overhead projector. Exemplary problems from practice are discussed. The students will be provided with a script and learning questions. All teaching materials as well as further information are made available in the Moodle platform. Individual help is available during the assistant's office hours.
In the exercises, the students solve given problems in the classroom, with the help of a teacher.
In addition to weekly classroom exercises, two practical field days should be organized during the course, including learning with machinery.

Media:

Reading List:
Renius, K-T. 2019. Fundamentals of Tractor Design. Springer.
References to further literature are given orally in the lecture. Also written down in the script chapter by chapter.

Responsible for Module:
Oksanen, Timo; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Tractor Engineering Fundamentals (Vorlesung, 2 SWS)
Oksanen T

Tractor Engineering Fundamentals (Übung, 3 SWS)
Oksanen T [L], Hefele R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2575: Terrestrial Ecology 1 | Terrestrische Ökologie 1

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Als Prüfungsleistung für das Modul dient eine 10-15seitige wissenschaftliche Ausarbeitung, in der die Studierenden die in der Übung erarbeitete Fragestellung vor dem Hintergrund der in der Vorlesung vermittelten Konzepte einführen, die in der Übung verwendete Methodik beschreiben, und die in der Übung erzielten Ergebnisse vor dem Hintergrund der Konzepte der Ökologie der Lebensgemeinschaften analysieren und bewerten sollen.
Anhand der wissenschaftlichen Ausarbeitung zeigen die Studierenden, dass sie die Konzepte und Methoden der Ökologie der Lebensgemeinschaften kennen und die Spezifika interspezifischer Interaktionen in eigenen Worten wiedergeben können. Sie zeigen, dass sie aus einer Beobachtung einer ökologischen Lebensgemeinschaft heraus grundlegende Hypothesen zum Funktionieren der Gemeinschaft entwickeln und selbst erhobene Daten zu Lebensgemeinschaften analysieren und interpretieren können.

Repeat Examination:

(Recommended) Prerequisites:
Modul „Ökologie“ (Grundvorlesung Ökologie)
Modul „Versuchsplanung“ (Grundkenntnisse der Versuchsplanung sowie statistischer Auswertungen in der Software R).

Content:
Das Modul umfasst folgende Inhalte:
- organismische Interaktionen und ihrer Rolle für die Strukturierung von Lebensgemeinschaften. Dabei liegt der Fokus auf positiven (Mutualismus) und negative (Prädation, Konkurrenz) Interaktionen.
- Methoden, wie die Struktur von Lebensgemeinschaften im Freiland untersucht
- Eigenschaften von Artengemeinschaften im Freiland

- Standardmethoden der Terrestrischen Ökologie
- eigene Beobachtungen im Freiland
- Analyse selbst erhobener Daten

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen kennen die Studierenden die Konzepte und Methoden der Ökologie der Lebensgemeinschaften. Die Studierenden können in eigenen Worten die Spezifika interspezifischer Interaktionen wiedergeben und sie verstehen, welche Faktoren Lebensgemeinschaften strukturieren. Die Studierenden sind in der Lage, aus einer Beobachtung einer ökologischen Lebensgemeinschaft heraus grundlegende Hypothesen zum Funktionieren der Gemeinschaft zu entwickeln und sie können Experimente entwickeln, um diese Hypothesen zu testen. Mit Hilfe der vermittelten Analysemethoden sind die Studierenden in der Lage, selbst erhobene Daten zu Lebensgemeinschaften zu analysieren und zu interpretieren.

Teaching and Learning Methods:
In einer Vorlesung werden theoretische Konzepte der Ökologie der Lebensgemeinschaften vermittelt. Die Vorlesung enthält Elemente eines Seminars, in dem die Studierenden mit dem Dozenten die Konzepte und ihre Anwendbarkeit auf Umweltprobleme diskutieren. In der Übung (Terrestrische Ökologie 1) werden ökologische Methoden im Freiland eingeübt, wobei die Studierenden die Fragestellung sowie die Methoden aus der Literatur mit Hilfestellung selbst erarbeiten.

Media:
Präsentationen (Powerpoint) vom Dozenten und Studierenden, selbst erstelltes Skript, Protokoll, wissenschaftliches Paper.

Reading List:
Peter J. Morin, Community Ecology, Blackwell Science, Oxford, U.K. 424 pages [Signatur UB: 1003/BIO 130f 2012 L 153(2)]

Responsible for Module:
Wolfgang Weisser (wolfgang.weisser@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Grundpraktikum Terrestrische Ökologie I (Praktikum, 4 SWS)
Meyer S [L], Meyer S

Ökologie der Lebensgemeinschaften (Vorlesung, 2 SWS)
Weißer W [L], Weißer W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1469: Advanced Concepts of Geographic Information Systems and Modelling | Weiterführende Konzepte der Geoinformationssysteme und Modellierung

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 120	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Der Leistungsnachweis im Modul besteht aus einer Klausur.
Mittels der Klausur (60 Minuten) soll nachgewiesen werden, dass die ausgewählten Konzepte zur Modellierung, Analyse und Visualisierung von drei- und vierdimensionalen (3D+Zeit) Geodaten, von Netzwerken sowie Systemarchitekturen für mobile Geoinformationssysteme verstanden werden. Darüber hinaus soll nachgewiesen werden, dass die genannten Modellierungskonzepte mittels GIS-Software angewendet und auf Anwendungsfälle in den Agrarsystemwissenschaften übertragen werden können. Dazu müssen in begrenzter Zeit Begriffe erklärt werden, sowie einfache Problemstellungen analysiert und basierend auf den im Rahmen des Moduls erworbenen Lernergebnissen, Lösungswege gefunden werden. Die Antworten erfordern teils eigene Formulierungen und Zeichnungen, teils Ankreuzen von vorgegeben Mehrfachantworten. Hilfsmittel sind nicht erlaubt.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse in Geoinformatik, wie sie beispielsweise im Module „Geoinformationssysteme und Modellierung“ des Masterstudiengangs Agrarsystemwissenschaften erworben werden können.

Content:
Die Modulveranstaltung vermittelt folgende weiterführende Konzepte und Anwendungen der Geoinformatik:

Repräsentation von dreidimensionalen Geodaten: 3D-Boundary-Representation, parametrische Geometrie, Triangulated Irregular Networks (TIN), Voxel
Digitale Höhenmodelle.
Virtuelle 3D-Stadt- und Landschaftsmodelle
Repräsentation der Dimension Zeit in Geoinformationssystemen: Snapshot-Ansatz, bitemporale Modellierung
Repräsentation von Netzwerken und Lineare Referenzierung
Mobile Geoinformationssysteme und Methoden für die Indoor- und Outdoorpositionierung (Globale Satellitennavigationssysteme GNSS, WLAN Fingerprinting)
Geodesign
Anwendung der oben genannten Konzepte mittels GIS-Software und Geodaten

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage ausgewählte Konzepte zur Modellierung, Analyse und Visualisierung von drei- und vierdimensionalen (3D+Zeit) Geodaten (3D-Boundary-Representation-Geometrie, parametrische Geometrie, TIN, Voxel, Snapshot-Ansatz, bitemporale Modellierung) sowie von Netzwerken zu verstehen und zur Lösung raumbezogener Fragestellungen mittels GIS-Software anzuwenden, Systemarchitekturen für mobile Geoinformationssysteme und Methoden für die Indoor- und Outdoorpositionierung zu verstehen, die grundlegenden Konzepte zur Modellierung und Analyse von 3D-Geodaten und Netzwerken auf Anwendungsfälle in den Agrarsystemwissenschaften zu übertragen, eigene Analysemodelle für Anwendungsfälle in den Agrarsystemwissenschaften zu entwickeln (zum Beispiel ein Modell für die Standortanalyse und -bewertung von Biogasanlagen).

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung und einer begleitenden Übung.
In der Vorlesung werden Konzepte zur Modellierung, Analyse und Visualisierung von drei- und vierdimensionalen (3D+Zeit) Geodaten sowie Systemarchitekturen für mobile Geoinformationssysteme vorgestellt.
In der begleitenden Übung sollen die in der Vorlesung vorgestellten Inhalte vertieft und insbesondere die Anwendung der Methoden mittels einer GIS-Software eingeübt werden. Dies geschieht in sechs vom Dozenten betreuten Übungsaufgaben zu den einzelnen Lehrinhalten des Moduls, die während der Präsenzzeit bearbeitet werden.
In einer weiteren Übungsaufgabe, sollen die Inhalte aus der Vorlesung und Übung auf einen ausgewählten Anwendungsfall in den Agrarsystemwissenschaften übertragen werden. Hierzu wird vom Dozenten ein Projektauftrag erteilt, der dann von den Studierenden in Kleingruppen während der Eigenstudiumszeit bearbeitet wird. Die Geodaten zur Bearbeitung des Projektauftrags werden teils vom Dozenten zur Verfügung gestellt und müssen teils mit Hilfe von Werkzeugen, wie dem Geoportal Bayern, bei behördlichen Datenanbietern recherchiert werden. Bei der Bearbeitung des Projektauftrags stehen den Studierenden der Dozent sowie Tutoren in wöchentlich abgehaltenen Tutorensprechstunden zur Seite.

Media:
Präsentationen, Tafelbild, Übungsblätter, GIS-Software

Reading List:
Wird für jedes Vorlesungskapitel bekannt gegeben.

Responsible for Module:
Kolbe, Thomas; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Master's Thesis | Master's Thesis

Module Description

WZ0045: Master's Thesis | Master's Thesis

Version of module description: Gültig ab winterterm 2017/18

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 30	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Alphabetical Index

A

B

C

D

E

F

G

H

I

J

L

M

N

O

P

Q

R

S

T

U