Module Catalog

TUM Campus Straubing for Biotechnology and Sustainability (TUMCS)
Technische Universität München

www.tum.de/
www.cs.tum.de/

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 academic department. 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 then different study programs 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).

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Module Description

CS0001: Foundations of Computer Science | Grundlagen der Informatik

Version of module description: Gültig ab winterterm 2023/24

Module Level:	Language:	Duration:	Frequency:
Bachelor	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:
Exam achievement shall be done in the form of a written test (90 minutes). Knowledge questions check the treated basic concepts of computer science. Small programming and modelling tasks test the ability to apply the learned programming and query languages and the modelling techniques in order to solve simple problems.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
In the module following contents are treated exemplarily:
- database management systems, ER modelling, relational algebra and SQL
- Python as programming language:
o Basic constructs of imperative programming ((if, while, for, arrays etc.)
o Object-oriented programming (inheritance, interfaces, polymorphism etc.)
o Exception handling
- Basic algorithms and data structures:
o Algorithm term, complexity
o Data structures for sequences (linked lists, arrays, stacks & queues)
o Recursion
o Hashing (chaining, probing)
o Search (binary search, balanced search trees)
o Sorting (Insertion-sort, selection-sort, merge-sort)

Intended Learning Outcomes:
After successful participation in this module students will be able to understand important fundamental terms, concepts and approaches of computer science. Particularly the students know fundamental concepts of programming, databases as well as algorithms and data structures.They are enabled to apply the learnt concepts to develop own programms for data storage and analysis.

Teaching and Learning Methods:
Lecture and practical exercises: In addition to a central exercise,
in which the concepts of the lecture were deepend on the basis
of examples, tutorials, in which simple tasks were solved on the computer under intensive support, impart important practical
basic skills of programming, in order to apply the self-study acquired knowledge. In the second half of the semester
students work on a practical project, that should deepen the
related unterstanding with regard to the desired learning
outcomes.

Media:
Slide presentation, blackboard, lecture and exercice recording, discussion forums in e-learning platforms; Working on the PC

Reading List:
- Heinz-Peter Gumm, Manfred Sommer, 2012, Einführung in die Informatik, Degruyter Oldenbourg
- Marco Emrich, 2013, Datenbanken & SQL für Einsteiger, Create space independent publishing platform

Responsible for Module:
Dominik Grimm (dominik.grimm@hswt.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Foundations of Programming (Exercise) (Übung, 2 SWS)
Grimm D [L], Eiglsperger J, Martello S

Foundations of Programming (Lecture) (Vorlesung, 2 SWS)
Grimm D [L], Grimm D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0001: Foundations of Programming | Foundations of Programming [FoP]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Exam achievement shall be done in the form of a 90 minutes written test (either written or e-test). Knowledge questions check the treated basic concepts of programming and algorithms. Small programming and modeling tasks test the ability to apply the learned programming language in order to solve simple problems.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
In the module following contents are treated exemplarily:
Python as a programming language:
- Basic concepts of imperative programming (if, while, for, lists, dictionaries etc.)
- File handling (reading, processing, writing etc.)
- Object-oriented programming (inheritance, interfaces, polymorphism etc.)

Basic algorithms and data structures:
- Recursion
- Search (e.g., binary search, balanced search trees)
- Sorting (e.g., Insertion-sort, selection-sort, quick-sort)

In the lectures and exercises, practical problems on real-world issues and topics related to sustainability are addressed, computer science-based solutions are developed and discussed.

Intended Learning Outcomes:
Upon successful completion of this module, students will be able to understand important fundamental concepts of programming, algorithms, and data structures. They will be able to apply the concepts learned to develop their own code and basic algorithms for scientific data analysis.

Teaching and Learning Methods:
Lectures to provide students with all the necessary programming and algorithmic fundamentals needed to independently develop their own analysis scripts and pipelines for scientific data analysis. In the labs, students will work on various programming tasks and write their own code to analyze specific case studies and real-world data.

Media:
Slide presentation, blackboard, lecture and exercise recording, discussion forums in e-learning platforms; Exercise sheets, Working on the PC

Reading List:
Learning Scientific Programming with Python, Christian Hill
Data Structures & Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser

Responsible for Module:
Grimm, Dominik; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Foundations of Programming (Exercise) (Übung, 2 SWS)
Grimm D [L], Eiglsperger J, Martello S

Foundations of Programming (Lecture) (Vorlesung, 2 SWS)
Grimm D [L], Grimm D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0001BOK: Technologies of Wood Processing Lecture | Technologien der Holzverarbeitung VL

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
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

CS0002BOK: Energy Water Economy and Electricity Market | Energiewasserwirtschaft und Strommarkt

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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

CS0003: Production of Renewable Fuels | Production of Renewable Fuels

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 learning results are going to be proven in form of a written exam of 90 Minutes. Along the problem set, it is checked whether the student is able to understand, improve and assess industrial processes for the production of renewable fuels. No aids permitted.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in chemistry, Fundamentals in Thermodynamics (e.g., Grundlagen der Thermodynamik), Fundamentals in Process Engineering (e.g., Introduction to Process Engineering)

Content:
Requirements for fuels, linkage of energetic and chemical value chains, fossil fuel production as reference, balancing and assessments (Well-to-Wheel), Hydrogen and methanol economy, alternative fuels on C1-basis, fisher-tropsch fuels, OME, bio-based oil fuels, biodiesel, green diesel, HEFA, bio-based alcohols, legislation of fuels.

Intended Learning Outcomes:
This module aims at making the students familiar with the industrial processes to produce renewable fuels. They are able to set up material and energy balances of these processes and assess their sustainability. Limitations with respect of raw material supply, energetic efficiencies and market requirements are understood. The students understand the interactions of fuel market and energy market.

Teaching and Learning Methods:
The module consists of a lectures and exercises. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students are encouraged to study the literature and examine with regards to content the topics. In the exercises learned theory is applied with a practical orientation by means of arithmetic examples.

Media:
Hybrid live lectures & asynchronous mini-videos allowing distance learning, lecture Script and exercises via online platform, excursions to fuel production plants

Reading List:
• Jacob A. Moulijn, Michiel Makkee, Annelies E. van Diepen: Chemical Process Technology, Wiley (2013).
• George Olah et al.: Beyond Oil and Gas: The Methanol Economy, Wiley VCH (2006)
• Volker Schindler: Kraftstoffe für morgen: Eine Analyse von Zusammenhängen und Handlungsoptionen, Springer (1997)
• Martin Kaltschmitt, Hans Hartmann, Hermann Hofbauer: Energie aus Biomasse; Grundlagen, Techniken und Verfahren,SpringerVieweg (2016)
• Jochen Lehmann, Thomas Luschtinetz: Wasserstoff und Brennstoffzellen, Springer (2014)

Responsible for Module:
Burger, Jakob; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Production of renewable fuels (Tutorial, Straubing) (Übung, 2 SWS)
Burger J [L], Burger J, Groh D, Rosen N

Production of renewable fuels (Tutorial, Garching) (Übung, 2 SWS)
Burger J [L], Burger J, Groh D, Staudt J

Production of renewable fuels (Lecture, Garching) (Vorlesung, 2 SWS)
Burger J [L], Burger J, Staudt J

Production of renewable fuels (Lecture, Straubing) (Vorlesung, 2 SWS)
Burger J [L], Burger J, Staudt J
For further information in this module, please click campus.tum.de or here.

Module Description

CS0003BOK: E-Business in the Economy of Agriculture and Food | E-Business in der Agrar- und Ernährungswirtschaft Seminar

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
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

CS0004: Process optimization | Prozessoptimierung

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:
The learning results are going to be proven in form of an oral exam. Along a given problem set it is checked whether the student is able to formulate and solve optimization problems in the feield of process engineering. No aids permitted. Total examination duration: 30 Minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Mathermatics (WZ1601) or Higher Mathematics

Content:
Basic balance equations of process engineering, differential-algebraic equation systems, flowsheet simulation, linear optimization programs and methods, nonlinear optimization programs and methods, discrete optimization programs and methods, Pareto optimization, solver selection, implementation in numerical software

Intended Learning Outcomes:
This module aims at making the students familiar with the basics of mathematical optmiziation. They are able to identify and characterize optimiation problems in technical applications in the field of chemical engineering. They are able to implement optimization problems into numerical software, to solve them and to interprete the results.

Teaching and Learning Methods:
The module consists of a lectures and exercises. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students are encouraged to study the literature and examine with regards to content the topics. The excersises are on the one hand

tutored classes, in which the students solve arithmetic excersises with pen and paper. On the other hand, the students do computer excersises with the software MATLAB.

Media:
Lecture notes, slides, excersises, program codes

Reading List:
· Biegler et al: Systematic Methods of Chemical Process Design, Prentice Hall, 1997
· Engeln-Müllges et al: Numerik-Algorithmen: Verfahren, Beispiele, Anwendungen, Springer Heidelberg, 2011
· Ullmann's Modeling and Simulation, Wiley-VCH, Weinheim, 2007

Responsible for Module:
Burger, Jakob; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung
Prozessoptimierung
2 SWS

Übung
Prozessoptimierung
2 SWS
Jakob Burger
For further information in this module, please click campus.tum.de or here.

Module Description

CS0004BOK: Actual and future oriented Items of Silviculture VLX | Aktuelle und zukunftsorientierte Themen des Waldbaus VLX

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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

CS0005: Introduction to Development Economics | Introduction to Development Economics

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor	**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 is carried out in the form of a written examination. Students should evaluate fundamental theories, methods and concepts of development economics in detail using examples. In doing so, they demonstrate that they can assess and analyze empirical evidence on economic development.
Type of examination: written, no aids allowed, duration of examination: 60 minutes
Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Microeconomics (CS0063)
Empirical research Methods

Content:
What does development mean in theory and empirically? How are countries classified and what effects does that have? What is poverty and food security? What role do natural resources play in prosperity in developing countries? What are the determinants of poverty at the micro level? What role do risk, demographics, formal and informal institutions, labor, property rights, access to capital or microfinance play in developing countries? These are some of the questions that decision-makers in both developed and developing countries have to discuss every day. This course provides the theoretical basis and empirical evidence for the analysis of such questions against the background of current development policy issues.

Intended Learning Outcomes:
After attending the module, students can understand what hinders development and what factors lead development to success. You will be able to apply fundamental theories, concepts and analytical techniques associated with microeconomics. Students learn the difference between growth and development, the measurement of inequality, poverty and food security, the importance of agriculture and natural resources in developing countries. Students are able to analyze current empirical evidence on economic development in developing countries and to critically read and question the scientific literature in the field of economic development.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. The interactive lecture takes place using Powerpoint and whiteboard. In addition, scientific articles from specialist journals are integrated into the lectures. In the exercise, students discuss theoretical concepts and their empirical relevance individually and/or in groups from different perspectives for selected countries based on the references presented.

Media:
Presentations, slide scripts, articles, online lecture examples

Reading List:
Alain de Janvry, Elisabeth Sadoulet (2016). Development Economics - Theory and Practice. Routledge; Michael Todaro, Stephen Smith (2012). Economic Development, Pearson.

Responsible for Module:
Faße, Anja; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Development Economics (Lecture) (Vorlesung, 2 SWS)
Faße A [L], Faße A

Introduction to Development Economics (Tutorial) (Übung, 2 SWS)
Faße A [L], Faße A, Shayo G
For further information in this module, please click campus.tum.de or here.

Module Description

CS0005BOK: Applied Agricultural Engineering | Angewandte Agrartechnik

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**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:

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

Module Description

CS0006BOK: Basics of Commodity Future Markets | Grundlagen von Warenterminmärkten

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
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

CS0007: Applied Microbiology and Metabolic Engineering | Applied Microbiology and Metabolic Engineering [MetabEng]

Version of module description: Gültig ab summerterm 2023

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 order to check whether students have understood the principles and relevant methods and techniques of applied microbiology and metabolic engineering not only in theory, but can also apply them practically, two forms of examination are used. On the one hand, the students answer questions on fermentation strategies during a written exam (90 min) and prove that they have understood the correlations of microbial metabolism. Allowed tools are calculators. Additional resources may be approved by the lecturer if required. The written exam can be repeated each semester. On the other hand, by drawing up written protocols for the laboratory tests carried out, the students demonstrate that they can carry out a selected production process and describe it quantitatively (for each experiment about 5 pages of protocol / not graded course achievement). Guidelines for protocol preparations are discussed. Insufficient protocols can be improved once according to suggestions provided. In case still insufficient the practical course, including the protocol can be repeated the following year.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals of Microbiology and Molecular Biology from the Bachelor's courses

Content:
Relevant techniques of applied microbiology and metabolic engineering:
- microbial metabolism (biosynthesis and degradation pathways) - industrial microbiology: production of alcohols, amino and organic acids, vitamins, antibiotics, enzymes, etc.
- bioprocessing techniques - metabolic engineering strategies (e.g. optimization of precursor and cofactor availability) - quantitative biology

- Strategies to engineer microbial systems for production of chemicals and fuels based on biogenic resources, side and waste streams.

Intended Learning Outcomes:
Upon successful completion of the module, students will be familiar with the principles and relevant methods and techniques of applied microbiology and metabolic engineering. The students have gained knowledge of microbial fermentation processes and are able to develop strategies for the manipulation of cellular metabolism for selected product classes. The students have learned how to quantitatively describe fermentation processes and calculate mass balances. After completing the practical course, students will be able to cultivate a production strain, optimize process parameters, analyze biomass, substrate and product concentrations, and create a carbon balance of the process.

Teaching and Learning Methods:
The contents of the lectures during the semester are conveyed by a talk of the lecturer, based on ppt-presentations.The blackboard might additionally be used to explain more complex relationships. To a limited extent, this can be supplemented by self-study of the literature mentioned in the lecture. In the practical course during the following semester break the implementation of the theoretically learned knowledge takes place, thereby the students' laboratory skills are trained with regard to the development and optimization of fermentation processes.

Media:
PowerPoint, whiteboard

Reading List:

Responsible for Module:
Blombach, Bastian; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Applied Microbiology and Metabolic Engineering (Lecture) (Vorlesung, 2 SWS)
Blombach B [L], Blombach B, Glawischnig E

Applied Microbiology and Metabolic Engineering (Practical course) (Praktikum, 2 SWS)
Blombach B [L], Blombach B, Glawischnig E, Hädrich M, Vital S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0007BOK: Apiculture | Bienenkunde

Version of module description: Gültig ab winterterm 2021/22

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

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

CS0007-1: Applied Microbiology and Metabolic Engineering | Applied Microbiology and Metabolic Engineering

Version of module description: Gültig ab summerterm 2023

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

CS0008: Enzyme Engineering | Enzyme Engineering [EE]

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
To proof whether the students are able to show ways to optimize enzymes in their properties and to perform this methodically, a written examination takes place with a duration of 60 minutes and a written seminar report must be created.The total grade consists of the written exam grade (67%) and the grade of the seminar report (33%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
This course aims to convey molecular biology and protein chemistry approaches to optimize enzymes especially by variation of the primary structure. Essential contents are: analysis of the limitation at the molecular level, rational methods, computer-based methods, evolutionary and combined procedures, high-throughput methods, robotics. The seminar aims to convey basic bioinformatical tools used in rational enzyme design such as ligand docking, energy minimization and rational introduction of mutations. These methods will be practiced on real enzymes and used to generate improved enzyme variants for a specific engineering target.

Intended Learning Outcomes:
After participating in the lecture the students will be able to indicate options for the improvement of technically limited enzymes, to estimate the necessary effort for these improvements and they own the theoretical ability to put these improvements into practice. After having participated in the seminar the students are able to use different bioinformatical tools for rational enzyme design and are able to evaluate the results of the generated informatical predictions.

Teaching and Learning Methods:
The lecture will be performed as ex-cathedra teaching to provide the students with all necessary fundamentals. In addition, the students review single methods and procedures by themselves e.g. based on current scientific literature and present this review to each other in a presentation. In the seminar, the students will be guided through the single steps of a rational enzyme engineering approach with the help of a script. The results of these steps will be summarized in a written report to put the single steps into a larger context.

Media:
PowerPoint, lecture script, scientific publications

Reading List:
Recommendations:
"Directed Enzyme Evolution: Screening and Selection Methods” (Methods in Molecular Biology) and “Directed Evolution Library Creation: Methods and Protocols” (Methods in Molecular Biology), both Frances H. Arnold, George Georgiou (publisher), Springer, Berlin
“Protein Engineering Protocols” (Methods in Molecular Biology), Katja M. Arndt and Kristian M. Muller (publisher), Springer, Berlin.

Responsible for Module:
Sieber, Volker; 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

CS0008BOK: Plant Physiology | Pflanzenphysiologie

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
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

CS0009: Enzymatic Biotransformations | Enzymatic Biotransformations [IBT]

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
The students should be able to understand and describe possibilities and limitations of established industrial enzymatic processes. This understanding and its application to derive ways to improve existing processes, making them more sustainable and to establish new ones, a written examination takes place with a duration of 90 minutes (approved tool: calculator). As a voluntary mid-term effort, the students can take part in three online test within the Moodle course of the exercise. If they achieve at least 65% of the points in these tests, a bonus of 0.3 will be credited on the grade of the written examination (however, an improvement of the grade from 4.3 to 4.0 is not possible).

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The lecture provides a broad overview about applications of enzymes in industrial processes and detailed insight into the corresponding technically important aspects by means of current examples. Essential contents are: industrially relevant properties of enzymes, essential enzyme classes and the most important enzymatic mechanisms, whole cell catalysis vs. enzyme catalysis, biocatalysis vs. classical chemical catalysis, methods of enzyme immobilization, enzymes in aqueous and non-aqueous systems, enzymatic reactions combined with chemical reactions, large-scale supply of enzymes. On the application side, biotransformations which are necessary for the conversion of biogenic ressources are treated as well as reactions for the synthesis of bulk chemicals, fine chemicals and food additives.

Intended Learning Outcomes:
After participating in the lecture the students will be able to review possible applications of enzymes in different chemical and technical processes, to understand the behaviour and limitation of enzymes in these processes and to derive ways to establish new reactions biocatalytically and to propose technically meaningful scenarios for newly developed enzymatic processes respectively.

Teaching and Learning Methods:
The lecture will be performed as ex-cathedra teaching which is interrupted by queries to familiarize students with all necessary basics and to stimulate independent, critical thinking. In the exercise, the students will deepen the knowledge they have learned and solve specific problems of varying complexity, either alone or in group work.

Media:
PowerPoint, white board, exercise sheets or online questions

Reading List:

Responsible for Module:
Sieber, Volker; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Enzymatic Biotransformations (Exercise) (Übung, 1 SWS)
Sieber V [L], Arana Pena S, Hupfeld E

Enzymatic Biotransformations (Lecture) (Vorlesung, 2 SWS)
Sieber V [L], Sieber V
For further information in this module, please click campus.tum.de or here.

Module Description

CS0009BOK: Plantbreeding for Horticulture and Pomiculture |

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

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

Module Description

CS0010: Advanced Downstream Processing | Advanced Downstream Processing

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** 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 exam performance is effected by a written test. Through calculation problems it is reviewed whether the students are able to select, characterise, and design the downstream process units that have been discussed in the lecture. The students prove that they have understood the basic principles behind the downstream units by answering comprehension questions. Exam duration: 60 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fluid separation processes, Downstream processing

Content:
The module gives a fundamental introduction into modern, advanced downstream processing technologies of bioprocesses. The taught contents include besides others: new technologies of chromatography and adsorption (simulated moving bed, extended bed adsorptions), separations using magnet particles, and extraction using aqueous two-phase systems.

Intended Learning Outcomes:
The lecture is aimed at familiarising the students with modern separation units for the downstreaming of biotechnological processes, e.g. simulated moving bed chromatography and magnet separators.. The students are qualified to understand, select, and design advanced separation units for the downstream processing. Thereby the basics for the comprehensive design of biotechnological processes are laid.

Teaching and Learning Methods:
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Presentations, slide scripts, exercises

Reading List:
Harrison, Roger G., et al. Bioseparations science and engineering. Topics in Chemical Engineering, 2015.; Rodrigues, A. (2015). Simulated moving bed technology: principles, design and process applications. Butterworth-Heinemann; Walter, Harry, ed. Partitioning in aqueous two–phase system: theory, methods, uses, and applications to biotechnology. Elsevier, 2012.

Responsible for Module:
Jakob Burger

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

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

Module Description

CS0010BOK: Access to Bioinformatics | Praktischer Einstieg in die Bioinformatik

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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

CS0011: Conceptual Design of Bioprocesses | Conceptual Design of Bioprocesses [CDBP]

Version of module description: Gültig ab summerterm 2023

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 exam performance is effected by an written exam (60 min). It is reviewed wheter the students know the fundamentals of chemical and bioprocess engineering and if they can apply this knowledge on the design and evaluation of complex processes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module "Bioprocess Engineering"

Content:
Basics of conceptual design of bioprocesses; Basics of computational process design including calculation of process parameters; transfer of fundamental scale-up criteria towards real problem solving; Balancing of all process streams; Deepened knowledge of engineering principles and efficient energy utilization; State-of-the-art examples for sustainable bioprocesses will be given which utilize agricultural residues, waste streams or synthesis gas, and, thus, protect the climate.

Intended Learning Outcomes:
The students are qualified to understand the fundamentals of design and calculations of biotechnological processes after the course. They will aquire knowledge of all aspects of process design.

Teaching and Learning Methods:
The module consits of lectures and tutorials. Contents of the lecture shall be imparted in speech and by presentation. In the exercises, performed as part of the module, learned theory shall directly be applied with a practical orientation by means of calculations and examples from

targeted aspects of bioprocess design. Additionally the students will be qualified by an in-depth knowledge of the design of unit operations including calculation of process parameters based on utilization of selected software tools (such as SuperPro Designer).

Media:
slides, interactive quizzes, scripts, practical exercises

Reading List:
Elmar Heinzle, Arno P. Biwer, Charles L. Cooney. Development of Sustainable Bioprocesses: Modeling and Assessment. Online ISBN:9780470058916

Responsible for Module:
Zavrel, Michael; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Conceptual Design of Bioprocesses (Exercise) (Übung, 2 SWS)
Dsouza V, Zavrel M

Conceptual Design of Bioprocesses (Lecture) (Vorlesung, 2 SWS)
Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0011BOK: Molecular Genetics of Yeasts and Hyphal Fungi | Molecular Genetics of Yeasts and Hyphal Fungi

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	Language: English	Duration: one semester	Frequency: winter semester
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

CS0012: Artificial Intelligence for Biotechnology | Artificial Intelligence for Biotechnology [AI]

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 takes the form of a presentation followed by discussion. The learning outcomes are verified by a group project (3-4 students per group). The presentation of the developed code and the results of the project will be done together as a group, with each group member presenting one part. The presentation should be equally divided among the group members. After the presentation, each group member is asked individual questions about the project. The final grade will be based on the presentation and results of the project (duration of presentation and questions: approx. 30 min depending on group size; approx. 8-10 minutes per student). As a voluntary mid-term effort, the students can take part in a multiple-choice test (duration: 10 minutes). If they achieve at least 65% of the points in this test, a bonus of 0.3 will be credited on the grade of the presantation (however, an improvement of the grade from 4.3 to 4.0 is not possible).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Mathematical Skills in Linear Algebra and Statistics as well as Programming Skills in Python are expected

Content:
Technologies that generate analyses or predictions based on data can be found in almost all areas of our daily life (e.g. recommender systems, autonomous driving, and credit card fraud detection). These methods are also important for analyzing biological and biomedical data, e.g. for finding novel patterns in biological data, predicting the disease state of a patient, or the 3D structure of proteins. In this course, we will learn the fundamentals of machine learning and will apply these methods to various real-world problems.

The following contents will be treated exemplarily:
- Similarity and Distance Metrics
- Data Preprocessing and Visualization
- Dimensionality Reduction (e.g., Principal Component Analysis)
- Classification (Nearest-Neighbor, Logistic Regression, Decision Trees, Support Vector Machines (SVM))
- Model Selection and Hyperparameter Optimization (Confusion Matrix and Evaluation Measures, Cross-Validation, Hyperparameter tuning techniques, Common problems such as Over- vs. Underfitting)
- Clustering (K-Means, Hierarchical Clustering)
- Regression Models (Linear Regression, Support Vector Regression)

AI-based technologies have the potential to support many areas of biotechnology and sustainability, e.g. by guiding downstream research with data-driven predictions or supporting decision-making with demand forecasts. In this course, we will look at suitable practical examples and demonstrate their potential.

Intended Learning Outcomes:
The students know the fundamental and most important artificial intelligence, especially machine learning, methods and are able to apply them independently on various real-world problems. The students learn the basics of the programming language Python (one of the leading programming languages in the field of machine learning) and are able to implement and apply machine learning algorithms in Python. In addition, students are able to visualize and interpret different types of data and results independently. Students will understand how artificial intelligence can support areas of biotechnology and sustainability and are able to assess the potential of AI-based approaches in sustainability projects.

Teaching and Learning Methods:
Lectures to provide the students with all necessary fundamentals of artificial intelligence, especially of machine learning which they will need to independently apply these concepts to real-world data. In the exercises the students are introduced to the programming language Python, as well as to apply and implement these algorithms for specific case studies.

Media:
The lecture shall mainly be done by using PowerPoint presentations. During the exercise the students work at PCs to gain confidence in using the programming language Python. Students implement various machine learning methods in Python (e.g. using Jupyter Notebooks) and apply them on various examples. Students work on real world problems to implement learnt skills and to gain confidence in applying these different methods independently.

Reading List:
Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.
Bishop, C. M. (2006). Pattern recognition and machine learning. Springer.
Raschka, S. (2017). Machine Learning mit Python. mitp Verlag.

Friedman, J., Hastie, T., & Tibshirani, R. (2001). The elements of statistical. Springer.

Responsible for Module:
Grimm, Dominik; 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

CS0012BOK: Laboratory Course in Molecular Genetics of Yeasts and Hyphal Fungi | Laboratory Course in Molecular Genetics of Yeasts and Hyphal Fungi

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
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

CS0013: Advanced Scientific Planning Based on Current Research Topics at TUM | Advanced Scientific Planning Based on Current Research Topics at TUM [MW2473]

Advances in Biotechnology; teamwork in student groups with state-of-the-art topics in biotechnology

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
Students submit a report (either a high quality, collaborative, scientific report in English that is marked by the supervising professor, or a review paper). The scientific report as well as the review paper should not exceed 20 pages unless the supervisor has agreed on a lengthier document. Individual contributions of the group members are tracked in the cloud based editor and this allows an individual assessment of the submitted document. For students who chose the review paper option it is envisaged to submit their review paper to a suitable science journal (possibly with revisions) where group members and supervisors are co-authors. Students demonstrate that they are able to structure and assess current knowledge in a systematic manner and strictly follow citation integrity practices. They include graphical and tabular data and information describing the state of the art in the chosen research topic. If students chose the project plan/scientific report, an actual implementation of the proposed research work targeting the knowledge gap may be envisaged.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
This course is in English only and a reasonable to high level of written and spoken English is required. On top of the English language requirement a substantial level of soft and social skills is highly desirable, since students have to master a topic in a team over a full semester.

Content:
During the face-to-face lectures on two consective days at the beginnning of the semester it is envisaged to communicate the following content:
-fundamentals of scholarly work
-literature survey with science databases
-reference management with zotero.org
-publishing of research
-collaborating in teams: conflict management, communication, emotional intelligence, empathy
-collaborative writing with a cloud based editor and introduction to Fiduswriter.org
-registration in Moodle together with an introduction to learning material made available on Moodle
-introduction to current biotechnology topics and knowledge gaps from TUM research chairs
An agenda of the 2-day face-to-face lectures at the beginning of the semester is available for download at https://syncandshare.lrz.de/getlink/fiLZ3CULyrCVBDU38xiDce3B/agenda_advances_in_biotechnology
Online supervision and tuition on a weekly basis is provided by a postdoc/research fellow/doctoral student and is based the Fidus writer cloud based editor (https://tum.fidus.org or https://fidus.tum.de) and further communication channels in Moodle. Once the common topic has been agreed on by the group, students write up a detailed scientific text that includes summaries, illustrations and tables about the chosen topic. This document as well as the course language is in English. Based on their findings and the state of the art in their chosen biotechnology topic the group draw conclusions with an emphasis on how to bridge knowledge gaps through future research. It is envisaged to submit the the review paper/scientific document created by the group in a scientific journal. Alternatively, if students choose the project plan, the document should allow an implementation of the proposed project plan in practice.

Intended Learning Outcomes:
Students enrolling in this course gain competence in producing an overview of current knowledge in a biotechnology topic from ongoing research at the TUM. Students are free to choose either a review paper about a given biotechnology topic or a research plan. Students acquire proficiency to outline, structure and assess current knowledge from the available literature in a systematic manner. This includes compiling graphical illustrations and tables from the literature and teaches students how to correctly cite from relevant literature sources under the adoption of scientific integrity practices.

Teaching and Learning Methods:
The two-day kickoff meeting at the beginning of the semester introduces students to fundamental concepts of successful teamworking principles through a mix of lectures, teaching videos and team building exercises. The know how acquired in the kickoff meeting forms the basis for the collaboration and supervision in the subsequent virtual student teams.
Literature surveys and research on the state of the art in the chosen biotechnology topic is supervised online on a weekly basis for the remainder of the semester. Interaction between student group and supervisor/postdoc/doctoral student occurs via Moodle and over the the cloud based editor (http://fidus.tum.de or http://tum.fidus.org) which allows simultaneous editing by individual students. Moodle functionality such as chat, forum, feedback fom supervisors is made available

for all members of the group. Video conferencing can be chosen as a further communication channel between students and supervisor. The simultaneous editing of the group document allows the formation of student groups from a remote campus without the need for face-to-face meetings. Traditional, asynchronous editing makes such a collaboration between physically distant campusses hard if not impossible.

The list of scientific topics/knowledge gaps in this module are replaced every semester and students can download this list from
https://syncandshare.lrz.de/getlink/fi7HYsPPgsWNtmgr1UGLpPVH/
topics_advances_in_biotechnology
Students are encouraged to read through the topics beforehand so that they can go for a research field that suits their personal preference and where they want to gain individual expertise. This simplifies the selection of the topic and the formation of the student group during the kickoff meeting at the beginning of the semester. Once the topic has been identified the mode of study is primarily self-study with permanent exchange and interaction with fellow members of the student group. The supervisor periodically reviews the progress of the group and provides sound advice and assistance to improve the quality of the document.

Media:
Students use the cloud based editor "Fidus writer" to author a scientific document in collaborative manner. The proposed reference management tool is Zotero.org.

Reading List:
Students need to conduct a comprehensive literature survey on their chosen science topic. The tool zotero.org allows reference management in groups. Relevant literature for the kickoff meeting:

The Leader's Guide to Emotional Agility (Emotional Intelligence), Kerrie Fleming, 1st edition, FT Publishing International, 2016, 208 pages, https://www.oreilly.com/library/view/the-leaders-guide/9781292083070/?ar and
https://learning.oreilly.com/library/view/the-leaders-guide/9781292083070/

“Academic Writing for Graduate Students: Essential Tasks and Skills”, by John M. Swales and Christine B. Feak,
paperback, 3 rd editition, 2012, ISBN-13: 978-0472034758 (several copies in TUM library)

The essentials of academic writing for international students, Stephen R. Bailey, 2015, ISBN: 9781317503729
https://opac.ub.tum.de/TouchPoint/singleHit.do?
methodToCall=showHit&curPos=1&identifier=2_SOLR_SERVER_234404024

Writing for Engineering and Science Students - Staking Your Claim, by Gerald Rau, 1st Edition, 2019, eBook ISBN
9780429425684, London, Routledge, 324 pages, https://www.taylorfrancis.com/books/writing-engineering-science-

students-gerald-rau/10.4324/9780429425684

Webster and Watson, “Analysing the past to prepare for the future: Writing a literature review”, MIS Quarterly, Vol.25, No.2, 2002, https://www.jstor.org/stable/4132319 (accessed January 2021)

“The scientific paper is obsolete, here is what is next”, The Atlantic Daily, https://www.theatlantic.com/science/archive/2018/04/the-scientific-paper-is-obsolete/556676/, last accessed 21Jan2021

Responsible for Module:
Sieber, Volker; 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

CS0013BOK: BOKU: Chemistry and Technology of Sustainable Resources | BOKU: Chemistry and Technology of Sustainable Resources

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
written (4-5 questions, 60% are required to pass), followed by an oral exam (10 - 15 min) Exams in person at Muthgasse 18, DCH, 3rd Floor, SEM 03/03

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic courses in chemistry

Content:
The lecture will cover selected topics on cellulose, cellulosic materials, starch and lignin. Including: Cellulose structure, dissolution, chromophores, cellulose solvents, fibers Aging and Degradation: Basic reactions of cellulose degradation, corrosion phenomena, mass-deacidification lignin structure, technical lignins and processes to obtain them, lignin analysis

Intended Learning Outcomes:
Deeper insights into lignocelluloses and biorefineries

Teaching and Learning Methods:
interactive lecture

Media:
interactive lecture

online lecture

Reading List:
Ek et al. (Eds). Pulp and Paper Chemistry and Technology Vol. 1-4, De Gryuter Fengel and Wegener "Wood", Klemm et al., Cellulose and cellulose derivatives" H. Sixta, Handbook of Pulp Holik, Handbook of Paper and Board J. Lehmann, Kohlenhydrate

Responsible for Module:
Thomas Rosenau thomas.rosenau@boku.ac.at

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

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

Module Description

CS0014: Research Internship Master Chemical Biotechnology | Research Internship Master Chemical Biotechnology

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 15	**Total Hours:** 450	**Self-study Hours:** 90	**Contact Hours:** 360

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

Description of Examination Method:
Exam achievement consists of a graded practical course report (15-25 pages) about contents and results of the practical course containing at least an overview of the level of knowledge relating to the project subject as well as representation of used working methods and a representation of the results including interpretation. In a final grade quality of familiarisation with the topic of experimental work, interpretation of results and written elaboration shall be evaluated.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
no

Content:
Research-related works at the chairs and working groups of the TUM Campus Straubing/Garching/Freising (area of biotechnology). The students shall each get tasks from the research field of the mentoring examiner. They shall work on these tasks under supervision in form of projects. Topics have to be allocated with regard to content and expertise to one of the core themes (cultivation, economy, material use, energetic use). The students shall largely independently plan project works under supervision of the mentors.
The project work includes 360 working hours, which are set in consultation with the supervisors, usually as a block internship on consecutive weeks, which can be deviated from in consultation with the supervisors. Project works shall be documented and evaluated in form of an internship report. Optionally a completing presentation of work progress may be done in form of oral presentations. Project works can also be done in cooperation with external institutions, e.g. companies.

Intended Learning Outcomes:
After having participated in the module the students especially understand principles of approach to (research) projects, planning of project works and critical evaluation of project results beside subject-specific knowledge and working methods each imparted in the practical course in scientific working. The students will be able to apply these principles to new project tasks. Besides they are able to document, to interpret and summarise project works and results in a meaningful way in written form.

Teaching and Learning Methods:
According to the core theme and topic, e.g. experimental equipment (laboratory), databases, libraries, subject-specific software, project and experiment design software

Media:
dependent on focus and topic e.g. experimental equipment (lab), databases, libraries,subject-specific software, project/ experiment planning software

Reading List:
Technical literature

Responsible for Module:
Sieber, Volker; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Internship Master Chemical Biotechnology (Blombach) (Praktikum, 15 SWS)
Blombach B [L], Blombach B, Glawischnig E, Hädrich M, Vital S

Research Internship Master Chemical Biotechnology (Costa) (Forschungspraktikum, 15 SWS)
Costa Riquelme R [L], Costa Riquelme R

Research Internship Master Chemical Biotechnology (Sieber) (Praktikum, 15 SWS)
Sieber V [L], Abbas Nia A, Al-Shameri A, Arana Pena S, Dsouza Z, Fornoni E, Friedrichs J, Fuchs A, Giustino A, Grundheber J, Hofer N, Hörnschemeyer K, Hupfeld E, Kampl L, Köllen T, Liu Y, Malubhoy Z, Marosevic M, Matena F, Mayer M, Ostertag T, Raga Carbajal E, Rau M, Romeis D, Rühmann B, Scheerer J, Schieder D, Schulz M, Sieber V, Siebert D, Skopp A

Research Internship Master Chemical Biotechnology (Prof. Zavrel) (Forschungspraktikum, 15 SWS)
Zavrel M [L], Beerhalter D, Borger J, Dsouza V, Geisler N, Marino Jara J, Oktay I, Stegemeyer U, van der Walt H, Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0014BOK: BOKU: Post-harvest Technology | BOKU: Post-harvest Technology

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
Written
The mark results from the evaluation of the written exam. The mark of the lecture will be derived from the reached percentage of the points as followed. 90 – 100 % = 1 78 – 89 % = 2 66 – 77 % = 3 55 – 65 % = 4 0 – 54 % = 5 (failed) Duration of the written examination = 60min. For the written exam you can bring calculator, ruler, german/englisch dictionary and the formulary supplied on the bokulearn plattform.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
Importance of post-harvest technology for the food chain
Biological and physical principles of post harvest technology
Selected post harvest technologies in agriculture:
Treatment of seed (drying, cleaning, sieving,?)
Alternative methods of seed treatments (warm-humid, microwave, high frequency energy)
Drying technology (principles and application; Ddying of agricultural products)
Crop conservation with silage making (principles and processes)
Storage of crops (potato, fruit, vegetable,?); Principles and applications
Special post-harvest technologies in horticulture and viticulture

Intended Learning Outcomes:
Understanding of biological and physical properties of harvested crops and their comprehension

Qualification for systematic analyses of post harvest technology

Qualification for planning of post harvest technology

Evaluation of post-harvest technologies on engineering fundamentals as well as ecological and economic aspects

Teaching and Learning Methods:
interactive lecture

Media:
Lecture, simulation software, presentations

Reading List:
PDF-files of the content are accessible via BOKU learn after login
Additional information will be made available via BOKU learn.
Recommended books will be discussed in the lecture

Responsible for Module:
Viktoria Motsch viktoria.motsch@boku.ac.at Andreas Gronauer Andreas.gronauer@boku.ac.at

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

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

Module Description

CS0015: Master's Thesis with Master's Colloquium | Master's Thesis with Master's Colloquium

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 100	**Contact Hours:** 800

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

Description of Examination Method:
The module examination consists of the preparation and positive evaluation of the Master´s Thesis (depending on selection of topics 25 to 75 pages) and the associated Master's Colloquium (60 minutes oral exam). The final grade consists of 5 parts of the grade of the Master's Thesis and one part of the grade of the Master's Colloquium.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
70 credits including all compulsory modules of the Master's program

Content:
consolidation of the knowledge of a specific biotechnological topic which is arbitrary in consultation with the supervisor / consolidation of practical skills in the lab / presentation of a research-based topic in the field of biotechnology

Intended Learning Outcomes:
After completion of the module, the students are able to work self-reliant on complex scientific problems on the basis of scientific methods and analytical thinking. The can present their results in a conclusive way, are able to discuss and to draw conclusions.

Teaching and Learning Methods:
First, the results of the related scientific project planning presented in the Master's Colloquium will be discussed. During the Master’s Thesis, the students work on a scientific problem. At this juncture amongst others literature research as well as lab work and presentations are used. The

actual teaching and learning methods depend on the respective problem and have to be discussed with the supervisor for each single case.

Media:
Specialist literature, software and so on

Reading List:
in consultation with the supervisor

Responsible for Module:
Volker Sieber

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

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

Module Description

CS0015BOK: BOKU: Gender, Food Systems and Natural Resources | BOKU: Gender, Food Systems and Natural Resources

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	Language: English	Duration: one semester	Frequency: winter semester
Credits:* 6	**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:
50% written annotated bibliography (individual grade) 50% presentation/podcast (graded as group work) Both components must be passed in order to pass the course. Students are expected to attend every session. For successful completion of the course attendance of at least 80% of lectures is required.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Interest in the topics relating to this course. Students from a diversity of disciplines and backgrounds are invited to join.

Content:
This course critically assesses how the use, management and knowledge of land, water and the wider ecology is gendered. While women's importance as users, guardians and managers of natural resources and their roles in enabling family food and nutrition security are highlighted globally, the rights to land, water and trees, as well as access to other resources, infrastructure and services, are vested in men. In this course we aim to understand these contradictions, and their implications in different farming systems, practices and socio-political contexts. We will investigate the theory, policy and practice of gender in the governance of food systems and natural resources; and analyse the shortcomings of attempts to integrate women into development programmes. This course will further introduce alternative rights-based approaches to food systems and natural resources, such as food sovereignty, food justice and the right to food, from the perspective of social movements and civil society. In order to achieve a more sustainable use of natural resources it is crucial to understand how and by whom they are used, managed and governed and what are the challenges and barriers, but also the opportunities for different actors. In order

to leverage a transformation toward food and nutrition security for all, a societal transformation is urgently required and more attention has to be paid to underlying structural power dynamics and inequalities among the actors involved. We will assess relevant Sustainable Development Goals (e.g., SDG2, SDG5, SDG12) and the role they play in these processes. To enable students to analyse and/or undertake research on people-nature-food linkages, we will explore conceptual frameworks, analytical insights and methodological tools stemming from different approaches to addressing gender. These frameworks will be based on thematic case studies that will provide deeper insights into different geographic, socio-economic and socio-cultural contexts.

Intended Learning Outcomes:
On completion of this course, students will be able to:
1. Understand meanings and interpretations of gender in theory, policy and practice, and how these impact on the development and governance of food systems and natural resources.
2. Assess how structural inequality and different forms of violence undermine diverse rights of people, with a focus on how this relates to the sustainability of natural resources.
3. Explore how social movements and civil society challenge the dominant agri-food system, focusing in particular on the concept and practice of food sovereignty, food justice and the right to food.
4. Critically assess diverse research approaches and methodologies and the positionality of researchers as well as ethical implications of research.
Students will gain key competences in:
- scientific reading and writing, working with academic literature through guided reading, presenting and discussing readings in class, writing an annotated bibliography (as part of the assessment, 50%)
- media-supported presentation skills, producing a podcast
- team work capacity
- facilitation skills, through active participation in different interactive formats (e.g., World Café, Fishbowl discussion) and online facilitation
- discussions and plenary debate
- peer review: receiving and providing guided feedback

Teaching and Learning Methods:
Learning will be facilitated through a variety of methods which may include lectures, seminars, workshops, presentations by guest speakers, group work and online activities. Students are expected to engage in both class and online activities and discussions. This course also requires students to participate in guided reading and self-directed study to support the learning gained from timetabled sessions. Required and optional readings will be uploaded in advance on BOKUlearn. The emphasis is on student participation and fostering dialogue and debate. Students should feel able to explore and develop their understanding of key concepts introduced in the sessions through discussions in a supportive but challenging environment. Each session will consist of lectures, interactive group activities and/or guest speakers. Case studies presented by guest speakers from academia and civil society, based on research, project and advocacy work, will enable students to gain insights into the social, political, economic and cultural conditions of development and practice in various regions of the world. Through in-class discussions and guided

learning activities, such as peer-review, students will receive continuous feedback, giving an early indication of progress towards the intended learning outcomes.

Media:

Reading List:

Doss, C., Meinzen-Dick, R.S. (2020). Land tenure security for women: A conceptual framework. Land Use Policy 99, 105080. Doi:

Portman, A. (2018). Food Sovereignty and Gender Justice. Journal of Agricultural and Environmental Ethics (2018) 31:455–466. https://doi.org/10.1007/s10806-018-9739-2 Titel anhand dieser DOI in Citavi-Projekt übernehmen

Right to Food and Nutrition Watch (2019). Women's Power in Food Struggles, Issue 11, October, Global Network for the Right to Food and Nutrition. Heidelberg/Berlin: Brot für die Welt & FIAN International.

Tsikata, D., Yaro, J.A. (2013). When a good business model is not enough: land transactions and gendered livelihood prospects in rural Ghana. Feminist Economics, http://dx.doi.org/10.1080/13545701.2013.866261 Titel anhand dieser DOI in Citavi-Projekt übernehmen.

Further required and optional readings will be made available on Moodle

Responsible for Module:

Stefanie Lemke Stefanie.lemke@boku.ac.at

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

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

Module Description

CS0016BOK: BOKU: Aspects of Product Quality in Plant Production | BOKU: Aspects of Product Quality in Plant Production

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 4	**Total Hours:** 100	**Self-study Hours:** 55	**Contact Hours:** 45

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

Description of Examination Method:
Written
Student Seminar Presentation + Seminar Paper

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge of plant cultivation, plant breeding and chemistry

Content:
General Section:
- Criteria of crop product quality
- Crop composition (proteins, oils, carbohydrates, fibres, vitamins, toxic components etc.)
- Analytical methods for crop quality determination

Section on Breeding for Quality Characters:
- Genetics of quality characters and quality breeding goals
- Wheat and rye (bread making quality)
- Malting barley, durum wheat and other special-use-cereals
- Oilseed rape and sunflower (oil content, fatty acid profile, ANF´s etc.)
- Soybean (protein and oil content, protein quality, trypsin inhibitor content)
- Fibre crops (fibre content and fibre quality)
- Starch- and carbohydrate-crops

Section on Agronomy:
- Environmental implications of crop quality

- Influence of agronomic treatments and cultivation techniques on crop quality

Practical Section:
- Introduction to NIRS (near-infrared reflectance spectroscopy)
- Breadmaking quality (baking tests, mini-extensograms, dough hardness, dough stickiness, ...)
- Rapid screening methods (tests for Kunitz trypsin inhibitor and for linolenic acid)
- Molecular genetic methods of quality analysis (protein- and DNA-markers)

Processing of crops
- Examples from the food/non-food industries (sugar, oil)

Intended Learning Outcomes:
Understanding the complex of product quality of harvest products. Integrating the effects of agronomy, genotype, environment on crop quality and harvest product utilisation. Experiencing important analytical screening methods used for determination of product quality.

Teaching and Learning Methods:
Lecture, student seminars, laboratory exercises, excursions

Media:

Reading List:
Presentation files are available

Responsible for Module:
Heinrich Grausgruber Heinrich.grausgruber@boku.ac.at

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

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

Module Description

CS0017: Regulation of Microbial Metabolism | Regulation of Microbial Metabolism

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**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:
The learning results are to be proved in form of a written test (60 min). The students demonstrate that they know relevant mechanisms of metabolic regulation and that they have understood the basic connections of microbial metabolism and its regulation dealt with in the module and can apply and transfer the methods and techniques.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successfully completed exams for Cell- and Microbiology (CS0256) and Molecular Biology and Genetic Engineering (CS0257) modules or equivalent modules.

Content:
Relevant topics of metabolic regulation: i.a. catabolite repression, attenuation, autogenous regulation, end product inhibition, 2-component systems, quorum sensing, regulatory RNAs, stringent control, nitrogen regulation, iron homeostasis, phosphate regulation

Intended Learning Outcomes:
Upon successful completion of the module, students will be familiar with the principles and relevant mechanisms metabolic regulation, including the ecological significance of microbial metabolism. This knowledge is the essential basis for the design of microbial systems for production of chemicals and fuels based on biogenic resources, side and waste streams. In addition, students are able to transfer the knowledge they have acquired in order to develop solutions to new problems.

Teaching and Learning Methods:
The contents of the lectures are conveyed by a talk of the lecturer, based on ppt-presentations. The blackboard might additionally be used to explain more complex relationships. To a limited extent, this can be supplemented by self-study of the literature mentioned in the lecture. Learning methods: During the follow-up of the lecture, the students intensively deal with the teaching contents of the lecture.

Media:
PowerPoint, whiteboard

Reading List:
Microbiology – an evolving science, J. L. Slonczewski, J. W. Foster, W W Norton & Co Inc, 4th edition, ISBN: 978-0-393-61403-9
Molecular Biology of the Gene, I. D. Watson, T. A. Baker, A. Gann, M. Levine, Losick, Pearson, 7th edition, ISBN-13: 978-0321762436

Responsible for Module:
Blombach, Bastian; 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

CS0017BOK: BOKU: Plant and Environment | BOKU: Plant and Environment

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
Written
written exam, 10 questions, mostly one per chapter, the overall grade results from the sum of the marks for individual questions, (max 11). Points/ grades: <5 points: 5, ≥5: 4, ≥6.5: 3, ≥8: 2, ≥9.5: 1

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
Introduction - stress, temperature - energy balance, light - quality and quantity, water and drought, flooding and oxygen deficiency, salt, heavy metals and phytoremediation, nitrogen and the N cycle, CO_2 and the global carbon cycle; herbivores, pathogenes and defence; genetically modified crops; invasive plants, ecosystem services

Intended Learning Outcomes:
Participants have theoretical and practical knowledge about the interactions between plants and their environment, how different environmental factors affect plants, plant adaptations to and also how plants affect their environment. They understand important local and global cycles. The knowledge establishes a basis for working on applied botanical and ecological problems.

Teaching and Learning Methods:

Media:

Reading List:
script and presentations will be made available via moodle
recommended books:
Schulze et al. Plant Ecology, Springer 2005
Larcher: Physiological Plant Ecology, Springer 2002

Responsible for Module:
Peter Hietz peter.hietz@boku.ac.at

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

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

Module Description

CS0018: Plant Biotechnology | Plant Biotechnology [PlBioTech]

Version of module description: Gültig ab summerterm 2023

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:
In a written exam (60 min) it will be evaluated to which extent the students are able to describe and assess the topics of the lecture correctly in appropriate scientific language.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successfully completed modules Cell- and Microbiology (CS0256) and Molecular Biology and Genetic Engineering (CS0257) or equivalent.

Content:
In the lecture the most important model and crop plants in biotechnology are presented, classified and their morphological and physiological properties are emphasized. Major questions, methods and solutions will be discussed with their pros and cons. Current topics will be discussed based on selected original publications. Some of the topics to be discussed: legal framework, major application of current plant genetic engineering, the Arabidopsis model system, novel concepts for yield and quality improvement. One focus is on the challenges for agriculture caused by climate change and sustainable solutions.

Intended Learning Outcomes:
The students know the most important methods and applications in plant biotechnology and are able to assess them.

Teaching and Learning Methods:
in the lecture the teaching content is communicated by a talk of the lecturer, supported by PowerPoint and skectches on the blackboard in which the latter form is chosen to derivate

complex relations. To a limited extent this can be completed for selected topics by self-study by the students.

Media:
PowerPoint, whiteboard

Reading List:

Responsible for Module:
Glawischnig, Erich; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Plant Biotechnology (Lecture) (Vorlesung, 2 SWS)
Glawischnig E [L], Glawischnig E
For further information in this module, please click campus.tum.de or here.

Module Description

CS0018BOK: BOKU: Soil Protection | BOKU: Soil Protection

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
Written

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Fundamentals of soil science (at least bachelor level, ideally the level after passing the exam of 911.014 - Soil Science Refresher) Proficient English

Content:
Introduction - Global issues and drivers of soil loss and degradation (theory / lecture) - Major soil threats at global, European and national level (theory / lecture) - Case studies covering different aspects of soil degradation and soil management (blended learning component: homework, peer review workshop).

Intended Learning Outcomes:
Overall aim: Provide an overview on major problems of soil protection and sustainable land use at global, European and national (Austrian) level. Objectives: - make you familiar with the main soil threats at global, european and national level - make you familiar with (sources of) information on the current state of soil - give you an appreciation of instruments of soil protection and their application to specific problems - encourage critical evaluation and challenging of current concepts of soil protection - provide guidance for informed use of soil information and decision making - enable you to develop possible solutions for better protection of soil Expected learning outcomes: - Know and comprehend fundamental soil threats - Recall the main soil threats - Know about major drivers and causes of soil degradation - Put them into context of natural, societal and economic conditions - Rank their relative importance at national, European and global level - Know about the state of soil (degradation) - Recall major pattern of soil degradation at national and European scale

- Know about sources of soil information and their application - Recall important sources of soil information in Austria, Europe and at global level - Make informed use of soil information - Know about instruments / measures of soil protection - Apply your knowledge to a case study

Teaching and Learning Methods:
interactive lecture

Media:

Reading List:

Responsible for Module:
Walter Wenzel walter.wenzel@boku.ac.at

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

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

Module Description

CS0019: Chemistry of Enzymes | Chemistry of Enzymes [COE]

Version of module description: Gültig ab winterterm 2022/23

Module Level: 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:
To proof whether the students are able to understand and to describe more complex enzymatic reaction mechanisms and deduce starting points for new enzymes from that, an oral examination takes place with a duration of 30 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The lecture first gives an insight into the kinetic processes of enzymatic reactions and their descriptions. Then the katalytic mechanisms from a chemical point of view are presented and analyzed by means of enzymes of all six enzyme classes (e.g. acid/base catalysis in hydrolases, one-electron reactions, oxygenation, radical catalysis etc), whereby here more complex mechanisms are illuminated. The different coenzymes are introduced and their interaction with the substrates and the protein backbone is explained. For selected enzymes the mechanisms are presented in relation to the applications.

Intended Learning Outcomes:
After participating in the module sessions, students will be able to understand which complex catalytic mechanisms proceed in enzymes and how they are analyzed. This enables them to assess which chemical reactions are enzymatically possible and which non-natural modifications are necessary to establish new reactions. Thus, the students can for example open up the function of newly found enzymes and develop new enzymes

Teaching and Learning Methods:
The lecture will be performed as ex-cathedra teaching to familiarize the students with all necessary basics. The lecture is interrupted by short exercises/question-answer units to stimulate independent, critical thinking. In the seminar, the students will acquire the mechanisms for selected enzyme systems in self-research, introduce them to their fellow students and solve in a group work concrete problems of varying complexity.

Media:
PowerPoint, script, task sheets

Reading List:

Responsible for Module:
Dr.-Ing. Ammar Al-Shameri

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

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

Module Description

CS0019BOK: BOKU: Forest Soil Biology | BOKU: Forest Soil Biology

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
The course is exam-immanent. Criteria are regular participation (at least 75%), commitment to practical work, evaluation and presentation of the results and active participation/discussion in the lectures

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
(1) Introduction to forest soil biology with a focus on biodiversity, litter degradation, humus formation and measurement methods for soil biological investigations.

(2) Excursions and method demonstration:
- Test area with automated greenhouse gas measurements as well as C, N and water balance
- Federal Research and Training Centre for Forests.

(3) Lectures: Degradation processes, influencing factors, important forest-soil organisms and their function, consequences of climate change for forest soils, online research and presentations on selected topics.

Intended Learning Outcomes:
Understanding the forest floor as a habitat for microorganisms, soil animals and plant roots. Insight into the interactions and activities of these organisms, their function and their dependence on the environment.

Teaching and Learning Methods:
Lecture with integrated exercises

Media:

Reading List:
Soil Biodiversity Atlas (freier Download unter: https://esdac.jrc.ec.europa.eu/content/atlas-soil-biodiversity)

Responsible for Module:
Andreas Schindlbacher Andreas.schindlbacher@boku.ac.at

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

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

Module Description

CS0020: Glycomics | Glycomics

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:** 105	**Contact Hours:** 45

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 (60 min). The students give definitions and draw or sketch the chemical structure. They answer comprehension questions about the methods covered in the lecture and explain the functional principles in words. Participation in the examination is subject to 90% attendance at the lecture and seminar.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A prerequisite for participation in this module is the successful completion of a course on instrumental analysis. Proof (module description, transcript of records) must be sent to Broder.Ruehmann@tum.de before the module starts. If you have obtained your Bachelor's degree in Chemical Biotechnology at the TUM Campus Straubing, you do not need to send us the module description, as we are familiar with the contents of the course. If the requirements are met, you will be admitted to the module, whereby a maximum of 20 students can be admitted. An insurance which covers damages in the laboratory is necessary.

Content:
The module teaches the basics of glycomics. The following are discussed: - Complexity of carbohydrates; - Structure and function of glycosylation; - Examples of biosynthesis; - Various analytical methods; - Elucidation of EPS structures

Intended Learning Outcomes:
After attending the module courses, students will be able to describe the basics of glycomics, illustrate the chemical structure and explain its functions. Furthermore, they should be able to illustrate analytical methods.

Teaching and Learning Methods:
In the lecture, the content is taught by means of a lecture by the lecturer, supported by ppt presentations and case studies. Exercise sheets are created for the course content, which students work on in self-study. The exercises are solved and discussed during the tutorials.

Media:
Presentation, script, lab and devices, measurement data and interpretation

Reading List:
script, Sample solutions to the exercises, publications

Responsible for Module:
Broder Rühmann

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

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

Module Description

CS0020BOK: BOKU: Agricultural Engineering in Plant Production | BOKU: Agricultural Engineering in Plant Production

Version of module description: Gültig ab winterterm 2022/23

[redacted]

production conditions), as well as sustainability aspects (by evaluating the environmental effects, future viability). The course's primary aim is not simply to communicate detailed information on agricultural engineering, but rather to contribute to a critical evaluation of processes and innovations in the course's areas of focus, as well as to determine problems and challenges in the selected fields of application.

Intended Learning Outcomes:
Upon positive completion of the course, students will be able to: • Give an overview of special topics in the field of agricultural engineering • Confidently use scientific literature (search, use and correctly cite literature) • Critically evaluate scientific literature • Participate in discussions based on the analysis of scientific literature and determine development potential, risks and open research areas

Teaching and Learning Methods:
The topic of the course paper can be chosen from a pool of topics, however each topic may only be researched once. The topic will be presented and clarified during the last course units. The content of the course paper will be a critical examination of one technology. The final paper should be structured as follows: 1. A short summary of the technology and its current state of development (ca. 500 words) 2. A summary of the technologies/innovations as described in the literature (ca. 1,000 words) 3. A critical evaluation of innovations (benefits, drawbacks, practical applicability), discussion supported by literature data (ca. 1,000 words) 4. A conclusion (max. 100 words) The course paper will be written about the individual technologies in 3-person groups. The course paper should be as short and concisely written as possible (no comprehensive “summary” of the literature); the suggested length of the paper is approximately 5-6 pages (2,600 words not counting the bibliography). The course papers should be based on the content of at least 10 scientific publications written in English. Results of the course paper will be presented visually in the concise format of a poster. Course leaders will make a template for the poster available to all course participants. Upon positive evaluation, posters will be approved for printing.

Media:

Reading List:

Responsible for Module:
Christoph Pfeifer

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

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

Module Description

CS0021BOK: BOKU: Crop Production Systems in Organic Agriculture | BOKU: Crop Production Systems in Organic Agriculture

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
written
Calculation of balances: example should calculated on student´s notebook and have to be submitted to BOKUlearn during the examination period

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in organic plant production (crop rotation)

Content:
Investigation and development of cropping systems with balance and planning instruments:

- designing of crop rotation
- fodder and straw balance
- organic manure planing
- nutrient balances (field, farmyard balance)
- humus balance

Intended Learning Outcomes:
Qualification for the system approach of organic farming land use systems:
- understanding of crop rotation interactions with soil, weeds and pests
- understanding connection between crop rotation, plant nutrition, fertilizer distribution, nutrient and humus balances
- understanding of nutrient and carboncycles between field and live stock (fodder budget)

Teaching and Learning Methods:
Lecture with exercises

Media:

Reading List:
Freyer, B. 2003: Fruchtfolgen - konventionell, integriert, biologisch. Verlag Eugen Ulmer, Stuttgart

Responsible for Module:
Gabriele Gollner Gabriele.gollner@boku.ac.at

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

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

Module Description

CS0022BOK: BOKU: Processes in Enzyme Technology | BOKU: Processes in Enzyme Technology

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Oral

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
The course will provide an overview of the key enzymes currently used in industrial processes. An overview of the technical use of enzymes and the possibilities to change and improve enzyme performance for adaptation to technical applications including enzyme optimization through enzyme discovery and engineering will be presented. A number of case studies highlighting the use of enzymes in industries e.g., starch conversion, food production, textile, wood fiber processing, biofuel production etc. will be explored.

Intended Learning Outcomes:
After passing the course, the students should be able to:
- understand the fundamentals of catalytic principles, enzyme kinetics and reaction mechanisms,
- explain the key structural factors which give rise to increased enzyme stability important for industrial applications,
- describe methods for selection and optimisation of industrial enzymes using genetic and biochemical techniques,
- describe and evaluate methods for enzyme immobilization and for characterization of the properties of immobilized enzymes

- describe a contemporary application of enzyme technology and present in a well-structured oral presentation.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Thu Ha Nguyen thu-ha.nguyen.ac.at

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

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

Module Description

CS0023: Gas-based bioprocesses | Gas-basierte Bioprozesse [EBT]

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German/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:
The exam performance is effected by an written exam (60 min). It is reviewed wheter the students know the fundamentals of gas-based bioprocesses and if they can apply this knowledge on the design and evaluation of gas-based processes.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
Terms and definitions of gas-based bioprocesses; deepened knowledge of microbial basics for gas conversion; basics and examples of the product spectra of gas-based bioprocesses; Basics of the design of the operation units necessary for gas-based bioprocesses.

Intended Learning Outcomes:
The students are qualified to understand the fundamentals of gas-based bioprocesses after the course. They will aquire knowledge of the different application fields of gas-based bioprocesses. Additionally they will be qualified by an in-depth knowledge of the design of operation units as well as the potential of this innovative field of biotechnology.

Teaching and Learning Methods:
The module consits of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of calculations and examples from targeted aspects of electrochemistry and electrobiotechnology.

Media:
Panel, slides, scripts

Reading List:

Responsible for Module:
N.N.

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

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

Module Description

CS0023BOK: BOKU: Biochemical Technology | BOKU: Biochemical Technology

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
oral exam dates can be arranged individually alternative, students can hand in a term paper (approx. length should be 15 pages) on a topic of biochemical technology which must be based on original literature and cover microbiological, biochemical and technological aspects of the production of selected chemicals / industrial products. These topics for the term paper can be selected individually

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
basic knowledge in microbiology and biochemistry (main metabolic pathways in microoragnisms) as wel as in biotechnology (cultivation of microorganisms, fermentation technology)

Content:
1. The lecture on 'biochemical Engineering' will give details about the production processes of some of the most important substrates used for fermentative processes or further transformations, starch, sucrose and plant oils. Alternative production of oil through fermentation by yeasts, fungi and algae.
2. Introduction to enzymes, enzyme catalysis and enzymatic processes; use of enzymes to produce glucose syrup from starch; enzymatic systems involved in the degradation of lignocellulose and conversion of lignocellulosic polysaccharides to fermentable sugars, enzymatic esterification in the production of biodiesel
3. fermentation processes to produce ethanol and other alcohols; lactic acid, succinic acid and other building blocks for the chemical industry; use of metabolic engineering to improve these fermentation processes

4. biocatalysis, definition, challenges and major examples

Intended Learning Outcomes:
after completing the course on 'Biochemical Technology' students will have a profound knowledge of important sources for fermentable sugars, enzymatic conversion of various polysaccharides to fermentable sugars, and the production of major chemical building blocks through fermentation and biocatalysis

Teaching and Learning Methods:
multimedia-supported

Media:
multimedia-supported

Reading List:

Responsible for Module:
Dietmar Haltrich dietmar.haltrich@boku.ac.at

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

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

Module Description

CS0024: Electrobiotechnology | Electrobiotechnology [EBT]

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:
The exam performance is effected by an written exam (90 min). It is reviewed whether the students know the fundamentals of electrochemistry and if they can apply this knowledge on the design and evaluation of electrobiotechnological processes.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
Terms and definitions of electrochemistry and bioelectrochemistry; deepened knowledge of physical-chemical fundamentals of electrochemical equilibria and electrochemical processes and reactions; fundamentals of electrochemical thermodynamics and electrochemical kinetics; fundamentals of electrochemical methods (with special focus on biological problems); bioelectrochemical processes in biological systems, especially microorganisms and enzymes; fundamentals of eletrobiotechnology especially on reactions, reactor technology and balancing. Examples of electroorganic syntheses, inter-relations with other subject areas (e.g. environmental biology); exemplarily applications in biosensoris and electrobiorefineries.

Intended Learning Outcomes:
The students are qualified to understand the fundamentals of electrochemistry and electrobiotechnology after the course. They will aquire knowledge of the different application fields of electrocchemistry as well as electroanalysis. Additionally they will be qualified by an in-depth knowledge of bioelectrochemistry especially of natural cellular bioelectrochemical processes as well as bioelectrochemistry of enzymes and microorganisms in combination how to apply them in electrobiotechnology.

Teaching and Learning Methods:
The module consits of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of calculations and examples from targeted aspects of electrochemistry and electrobiotechnology.

Media:
Panel, slides, scripts, exercise sheets

Reading List:

Responsible for Module:
Plumeré, Nicolas; 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

CS0024BOK: BOKU: Engineered Wood Products | BOKU: Engineered Wood Products

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
written preparation, oral examination interview The material of the last semester is relevant for the examination.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Prior attendance of the course 892323 materials is recommended.
Basic knowledge of mechanics or statics is required.

Content:
Selected material properties and their significance
Engineering of new materials
Material
Supporting elements and beams made of wood-based materials (BMS, LVL, LSL, PSL, I-beam)
Panel materials for load-bearing purposes
Panel materials for non-load-bearing purposes
Wood composite materials

Intended Learning Outcomes:
Students have ...
Knowledge of the properties of materials and their possible use for wood-based materials
Knowledge of the basics of material testing and material properties as well as material selection
Basics of 'engineering' (physical, economic and process aspects)

Overview of the wood-based materials available on the market, their properties and know the relationships that lead to these properties, as well as the areas of application of these materials

Teaching and Learning Methods:
Lecture

Media:

Reading List:
Powerpoint-Folien

Responsible for Module:
Johannes Konnerth johannes.konnerth@boku.ac.at

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

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

Module Description

CS0025: Advanced Analytics for Biotechnology | Advanced Analytics for Biotechnology [AdInstAna]

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
Examination: A 60-minute written examination in which students demonstrate their ability to solve analytical problems using a combination of experimental and theoretical methods. No aids are allowed in the examination. Participation in the examination is subject to a 90% attendance in the lecture and seminar.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisite for this module is the successful completion of a course in Instrumental Analytics including GC/MS and LC/MS. Proof (module description, transcript of grades) must be sent to corinna.urmann@tum.de before the start of the module. If you have obtained your Bachelor degree in Chemical Biotechnology at the TUM Campus Straubing, you do not need to send the module description, as we know the content of the lecture. If the requirements are met, you will be admitted to the module with a maximum of 10 students. An insurance for damages in the laboratory is necessary.

Content:
The module deals with chromatographic methods such as GC and LC (sampling, sample preparation, sample separation) in combination with different detection options such as MS, MS/MS (e.g. high resolution). In addition, different evaluation methods (practical and theoretical) for structure determination or compound identification are covered.

Intended Learning Outcomes:
After successful participation in the module, students will be able to recognise the potential applications of the methods as well as their limitations. Understand and confidently discuss

the methods and techniques presented, as well as terms and abbreviations. Apply evaluation procedures and principles of documentation and reporting correctly. Independently formulate challenging analytical questions, identify appropriate analytical techniques and combine experimental and theoretical methods to solve the problems.

Teaching and Learning Methods:
The teaching methods used are the lecture with PowerPoint support, as well as teaching videos, open source software and additional material. In the seminar, students will work on practical examples and present their results to their colleagues.

Media:

Reading List:

Responsible for Module:
Dr. Corinna Urmann

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

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

Module Description

CS0026: Advanced Concepts of Bioinformatics | Advanced Concepts of Bioinformatics

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:
Learning outcomes shall be verified in a written test. Tasks shall be specified by means of which the students are to demonstrate that they know the bioinformatic methods imparted as part of the module and that they have understood and are able to apply them for specific case studies. Exam duration: 90 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Module Biochemistry, WZ1631 Bioinformatics, CS0001 Foundations of Computer Science, Knowledge Linux Command Line Interface, Programming Skills in Python

Content:
In this course state-of-the-art methods in statistical genetics, genome-wide association studies, analysis of complex biological networks, protein-analysis as well as modern machine learning methods for genomic data are investigated and applied on various case-studies.

Intended Learning Outcomes:
The students know state-of-the-art bioinformatics methods and are able to apply them independently on various real-world problems. The students lern to implement custom Python scripts to analyse, visualise and interprete the results of these methods independently.

Teaching and Learning Methods:
Lectures to provide the students with the theoretical and practical concepts of state-of-the-art bioinformatics methods, which they will need to independently apply these methods on real-

world data. In the exercises the students will apply these tools on concrete case studies and will implement custom Python scripts to analyze, visualize and interpret the results.

Media:
The lecture shall mainly be done by using PowerPoint presentations. During the exercise the students work at PCs to gain confidence in using the bioinformatics tools. Students implement various custom Python scripts (e.g. using Jupyter Notebooks) to analyze, visualize and interpret the results of these tools. Students work on real world problems to implement learnt skills and to gain confidence in applying these different methods independently.

Reading List:
Pevsner, J. (2017). Bioinformatics and functional genomics. Wiley Blackwell.

Responsible for Module:
Dominik Grimm

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

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

Module Description

CS0026BOK: BOKU: Energy Engineering | BOKU: Energy Engineering

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
written
Multiple Choice Test: 30 Fragen in 60 minutes, 1-5 answers could be correct

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Physics including thermodynamics (e.g. VO 892.104 + VO 893.103 or VO 892.105 + VO 893.112)

Content:
Steam power plants • Combined heat and power (CHP) production • Waste incineration plants • Gas turbine combined cycle power plants • CO2 capture and storage • Power to Fuel (Gas / Liquid) • Heat grids and district heating systems • Heat pumps and active waste heat recovery • Energy technology in buildings

Intended Learning Outcomes:
The students know the essential parts of the present energy system and the approximate share of the different primary energy sources in Austria. • The students know the basic principles of energy conversion including the conversion of thermal energy to electrical energy. • The students know examples of practical energy conversion units and are able to explain the processes. • The students are able to discuss different energy conversion routes on a comparative basis.

Teaching and Learning Methods:
class lecture

Media:

Reading List:

Responsible for Module:

Tobias Pröll tobias.proell@boku.ac.at

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

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

Module Description

CS0027: Behavioral Economics | Behavioral Economics

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
There will be a written exam with a duration of 60 minutes, to show that students acquired detailed knowledge of behavioral economics and can apply its insights to relevant problems.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
VWL/Economics

Content:
This course provides a general introduction to behavioural economics and discusses its relevance to problems in the area of environmental policies. The first half of this course covers basic concepts of behavioural economics, discusses the short-comings of the economic standard theory, and illustrates how behavioural economics supplements the standard theory. In the second part of the course, the learned concepts will be applied to environmental policies and topics in environmental economics (e.g., green nudges, eco-labels, defaults,..)

Intended Learning Outcomes:
The students learn the basic concepts in behavioral economics. They will be able to identify possible applications to environmental policies and in the area of sustainability.

Teaching and Learning Methods:
The lecture will be performed as ex-cathedra teaching to provide the students will all necessary fundamentals. Within the tutorial the students learn through example calculations and homework how to transfer and apply this knowledge. Lectures and tutorials will be supplemented with classroom experiments

Media:
Slides, exercise sheets, additional literature (book chapters and articles)

Reading List:
The material in the lecture is sufficient for learning and is provided in the lecture.

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Behavioral Economics (München) (Vorlesung mit integrierten Übungen, 4 SWS)
Goerg S [L], Goerg S, Kopsacheilis O
For further information in this module, please click campus.tum.de or here.

Module Description

CS0027BOK: BOKU: Resource Efficiency and Bioeconomy of Bio-based Materials | BOKU: Resource Efficiency and Bioeconomy of Bio-based Materials

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	Language: English	Duration: one semester	Frequency: summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
Ongoing evaluation within the framework of the course (examination immanence)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
•Environment and society: regional and global developments
•Resource efficiency, material efficiency, sustainability
•Cascading usage concepts with wood and their evaluation
•The cradle-to-cradle principle and product and process innovations derived from it
•Bioraffineriekonzepte
•Material resource efficiency and economic development
•Evaluation of resource and material efficiency
•Improving resource efficiency and innovation strategies
•Resource efficiency in agriculture, forestry, wood industry, industrial biotechnology and its assessment (case studies)
•Definitions of the bioeconomy as well as international strategies and scenarios
•Sustainable bioeconomy, the bioeconomy "at any price", ethical aspects
•Products made from renewable raw materials and residues (building materials, insulation materials, bio-based composites, adhesives, biopolymers, bio-based lightweight materials, special products, etc.)

Intended Learning Outcomes:
•Define "resource efficiency" qualitatively and quantitatively.
•A sound understanding of the term bioeconomy is available, including currently defined strategies for implementation.
•Ability to discuss and evaluate critical and controversial issues in the context of resource efficiency or bioeconomy, including ethical and societal aspects.
•Cradle-to-Cradle is understood as a possible guiding principle of the future.
•Students are familiar with best-practice examples.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Georg Gübitz Georg.guebitz.boku.ac.at

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

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

Module Description

CS0028: Physics | Physics [Phys]

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor	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:
Achievement of desired learning objectives shall be verified in a written final exam (90 minutes). In this respect, the students demonstrate that they know and understand the concepts of mechanics, thermal engineering, electricity and optics. By using specific physical issues (mainly computational tasks), the students demonstrate that they are able to also use acquired concepts in a solution-oriented way in simple cases.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Good A-level knowledge of mathematics

Content:
The module of physics provides an introduction into classical physics. The module introduces into the math-based approach of physics for nature description. The module outlines the basics of mechanics, thermal engineering, electricity and optics, makes them clear by means of examples and further practices them by self-employed work.

Intended Learning Outcomes:
The module serves to acquire physical basics. The students know and understand the basic concepts of mechanics, thermal engineering, electricity and optics and can apply these concepts in simple cases. Therefore, a solid basis is created for the course participants that is necessary to understand the subsequent content of teaching (e.g. thermodynamics, energy technology).

Teaching and Learning Methods:
Lecture (speech by teaching staff including writing on the board, PP media, books and other written material), exercise (self-employed work on exercises related to the topics of the lecture in small groups with tutors) for further practising of the concepts which were presented in the lecture.

Media:
Writing on the board, presentations, slide scripts

Reading List:
Paul P. Urone, Roger Hinrichs: College Physics, OpenStax, Houston, 2022 (https://openstax.org/details/books/College-Physics)

U. Harten: Physik, Einführung für Ingenieure und Naturwissenschaftler (Physics, Introduction for Engineers and Scientists), 4th edition 2009, Springer

Responsible for Module:
Kainz, Josef; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Physics (Lecture) (Vorlesung, 2 SWS)
Kainz J [L], Kainz J

Physics (Exercise) (Übung, 2 SWS)
Kainz J [L], Kainz J, Sun J
For further information in this module, please click campus.tum.de or here.

Module Description

CS0028BOK: BOKU: Wood-Industrial Processes: Wood- and Fibre-based Materials | BOKU: Wood-Industrial Processes: Wood- and Fibre-based Materials

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
basically written; 65% needs to be reached

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Wood-based composites; first lecture will be a recapitulation.

Content:
Current Topics in Development of wood-based composites materials
Recovered Wood in wood-based composites materials
Recycling of wood-based composites materials
Testing of wood-based composites materials

Intended Learning Outcomes:
Familiarity with techniques and processes relevant in wood industrial manufacturing. Acquaintance with the processing and installation engineering to lead to solid wood products and wood-based composite materials. Get to know factors that affect manufacuring processes and product performance.

Teaching and Learning Methods:
Interactive lecture

this is a "blended learning" lecture, means half is given is given in a face-to-face classroom situation, the other half is provided through videos uploads on moodle.

Media:

Reading List:

Responsible for Module:
Rupert Wimmer rupert.wimmer@boku.ac.ar

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

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

Module Description

CS0029BOK: BOKU: Composite | BOKU: Composite

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	Language: English	Duration: one semester	Frequency: winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
In preparation for the exam, a calculation example must be solved. The information, for example, is handed over individually when registering for the exam. In the oral part of the exam, the solved example is discussed and further questions from the lecture material are asked.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Students taking the exam are expected to be familiar with the material of the lectures: natural fibers, wood physics, and natural fiber materials and technologies.

Content:
The focus of the lecture is on mechanical properties of reinforcing fibers and composites in the micro and macro range, as well as on special features of lignocellulosic fibers in composite materials.

Intended Learning Outcomes:
The course aims to provide a basic understanding of the mechanical properties of composite materials, as well as the special features of bio-based composites.

Teaching and Learning Methods:
Lecture

Media:

Reading List:

Responsible for Module:
Wolfgang Gindl-Altmutter wolfgang.gindl@boku.ac.at

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

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

Module Description

CS0030BOK: BOKU: Wood and Fibre Quality | BOKU: Wood and Fibre Quality

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
written exam

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
1st lector: Functional cambium and wood formation
1 st lector: Wood, paper and fibre properties of interest, Advanced methods for wood and fibre characterisation
2 nd lector: Within-tree variability, conceptual models
2 nd lector: Wood structure-property relationships
3 rd lector: Links between wood / fibre / paper properties and environmental factors
3 rd lector: Improvement of wood quality, plantation forestry, Wood and fibre quality for wood composites

Intended Learning Outcomes:
Wood and fibres are products of the cambium and it they are based on cells that have passed through various phases of development. This biological process is related to wood and fibre quality, the latter being the arbitrary evaluation of an isolated piece of wood, tree part, piece of paper or any other wood derivative for a certain use. In this respect wood formation is the process, wood and fibre quality and related products are results.

The lecture introduces to basic relationships and that are important to wood and fibres originating from fast-grown plantation, regular managed forests but also from high-elevation sites. The ultimate goal is to understand biological and environmental factors that affect wood and fibre quality as well as advanced wood materials, and how to control property variability.

Teaching and Learning Methods:
multimedia-supported

Powerpoint-based lecture, group discussions, content flexibility depending on interest and interaction dynamics

Media:

Reading List:
Wimmer, R., Downes, G.M., Evans, R., French, J. (2008): Effects of site on fibre, pulp and handsheet properties of Eucalyptus globulus. Annals of Forest Science 65 (6)

Wimmer, R. (2002): Wood anatomical features in tree-rings as indicators of environmental change– a review. Dendrochronologia 20(1-2): 21-36.

Downes, G.M., Wimmer, R., Evans, R. (2002): Understanding wood formation: Gains to commercial forestry through tree-ring research. Dendrochronologia 20(1-2): 37-51.

.....more literature is discussed during the first lecture

Responsible for Module:
Rupert Wimmer rupert.wimmer@boku.ac.at

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

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

Module Description

CS0031BOK: BOKU: Mechanical and Thermal Process Technology II | BOKU: Mechanical and Thermal Process Technology II

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 75	**Self-study Hours:** 30	**Contact Hours:** 45

Number of credits may vary acpdfnoffnohnohi rmcfaef eff oher opp ber fy ac

7 reactors

8 Dwell time and dwell time spectrum

Intended Learning Outcomes:
Based on the lecture MTV I, modern separation processes, which are of growing importance for food as well as for biotechnology, are presented in more detail. In addition, reaction process engineering is a very important area of process engineering that is systematically presented from the basics to the application, which flows into many other courses, but has so far only been presented very briefly and incoherently. Towards the end of the course, it is taught how the previously acquired knowledge, which has largely been limited to individual process steps (unit operations), can be integrated into entire processes.

Teaching and Learning Methods:
Lecture with integrated exercises

Media:

Reading List:

Responsible for Module:
Senad Novalin senad.novalin@boku.ac.at

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

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

Module Description

CS0032: Seminar on Optimization Methods and their Application | Seminar on Optimization Methods and their Application [SemOMA]

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**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 seminar paper as well as an oral presentation & discussion. The seminar paper should cover 15–20 pages and be written in the style of current publications of peer-reviewed journal articles. In addition to the seminar paper, optimization models and methods may have to be implemented in order to conduct numerical analyses, which will be handed in as a digital appendix. At the end of the module, students present their work in a 45 minutes presentation. Both parts (the written paper and the presentation) are weighted equally to the final grading.

Repeat Examination:

(Recommended) Prerequisites:
The module covers optimization models and methods and their application in operations research. To study these models and methods, methodological knowledge on optimization methods as obtained, e.g., in the module CS0098 (Operations Research) is required.

Content:
The seminar focuses on recent research developments on varying topics related to optimization methods and their application in operations research. Students learn to model practical problems arising in different areas of operations research as optimization problems and to solve the resulting problems using suitable methods. Thereby, mathematical optimization models and methods from areas such as (mixed-integer) linear programming and network optimization (e.g., shortest path or network flow problems) are used to solve relevant practical problems.

Intended Learning Outcomes:
The objective of the module is to equip the participants with the necessary skills for writing academic papers and tools for a successful master's thesis project.

Specifically, the aim is to be able to:
- Read and understand recent research contributions
- Pursue interesting and relevant research questions
- Conduct a literature study and/or numerical study and/or implementation concerning a specific topic
- Structure and organize research methods and results
- Write a seminar paper
- Present research findings and defend them in an academic discussion

Teaching and Learning Methods:
In an introductory session, the current theme of the module is explained by the lecturer and the various available seminar topics are elaborated in detail. Moreover, information on relevant literature for the problem settings is introduced, which forms the basis of the students' seminar papers. After the introductory session, students will work out their assigned topics independently own or in small groups by using their abilities of conducting literature research, mathematical modelling, programming, and quantitative analyses. Throughout the project, they receive guidance from a supervisor. Different milestones such as a preliminary outline of the seminar paper, first research results, and the final paper are to be achieved. Following the submission of the final paper, presentations and discussions of all students' seminar papers are conducted, where also presentation, moderation, and discussion skills are trained.

Media:
Research paper; presentation slides

Reading List:
F. Petropoulos et al. - Operational Research: Methods and Applications, Journal of the Operational Research Society, Volume 75, Issue 3, pp. 423-617 (2024)
M. Carter, C. C. Price, G. Rabadi - Operations Research: A Practical Introduction (2nd ed.), Chapman and Hall/CRC (2018)

Responsible for Module:
Thielen, Clemens; 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

CS0032BOK: Small scale forestry | Kleinwaldwirtschaft

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 2	**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:
Written

Repeat Examination:

(Recommended) Prerequisites:

Content:
Position of the small-scale forests in the forestry of Austria and the EU; Condition and management of the small-scale forests; Significance of the branche of business forestry for the small-scale forest owners; Education and further training, advice, support, project management; Organization of the cooperation.

Intended Learning Outcomes:
Arrangement of knowledge about the management of the small-scale forests, the education and further training, advice, support and cooperation of the small-scale forest owners.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Werner Löffler

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

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

Module Description

CS0033: Accredited Module 3 ECTS | Anerkanntes Modul 3 ECTS

Version of module description: Gültig ab winterterm 2018/19

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

CS0033BOK: BOKU: Applied Measurement and Control Systems | BOKU: Applied Measurement and Control Systems

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 30	**Contact Hours:** 45

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

Description of Examination Method:
Examination immanent (attendance, cooperation, final test) Presentation of one technical term each 20 pts (1 measurement technology and 1 control technology), 2 homework of 30 pts each (1 measurement technology and 1 control task)

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basics of measurement and control technology (VO MRI I).

Content:
Practical examples from measurement and control technology. Participants learn typical problem definitions, solutions and modeling techniques.

Intended Learning Outcomes:
Students have the ability to develop solutions for typical measurement tasks.
Students can estimate measurement errors and consequential errors based on them.
Students are familiar with a modeling program (MATLAB or similar) for control systems.
Students have the competence to discuss measurement principles and their measuring ranges.
Students have the competence to discuss controller designs and their areas of application.

Teaching and Learning Methods:

Media:

Reading List:
Skript Mess- und Regeltechnik I, Teil 1 und 2; further literature will be given in the lecture.
Strohrmann G.: Meßtechnik im Chemiebetrieb, Verlag Oldenbourg.
Niebuhr J., Lindner G.: Physikalische Messtechnik mit Sensoren, Verlag Oldenbourg.
Weichert N., Wülker M.: Messtechnik und Messdatenerfassung, Verlag Oldenbourg.
Freudenberger A.: Prezessmesstechnik, Vogel Buchverlag.
Fritz W.: Regelungstechnik mit SPS, Vogel Buchverlag.

Module Description

CS0033-2: Accredited Module 3 ECTS | Anerkanntes Modul 3 ECTS

Version of module description: Gültig ab summerterm 2020

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

CS0033-3: Accredited Module 3 ECTS | Anerkanntes Modul 3 ECTS

Version of module description: Gültig ab winterterm 2020/21

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

CS0033-4: Accredited Module 3 ECTS | Anerkanntes Modul 3 ECTS

Version of module description: Gültig ab winterterm 2022/23

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

CS0033-5: Accredited Module 3 ECTS | Anerkanntes Modul 3 ECTS

Version of module description: Gültig ab winterterm 2022/23

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

CS0033-6: Accredited Module 3 ECTS | Anerkanntes Modul 3 ECTS

Version of module description: Gültig ab winterterm 2022/23

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

CS0033-7: Accredited Module 3 ECTS | Anerkanntes Modul 3 ECTS

Version of module description: Gültig ab winterterm 2022/23

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

CS0034: Accredited Module 5 ECTS | Anerkanntes Modul 5 ECTS

Version of module description: Gültig ab winterterm 2018/19

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 5	**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

CS0034BOK: BOKU: Computer Simulation in Energy and Resource Economics | BOKU: Computer Simulation in Energy and Resource Economics

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
Weekly Assignments (50% of points) Final oral examination (50% of points) Extra points in the human-zombie deathmatch

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic programming knowledge in any programming language (R, Python, C, Java, VB-Script, etc...) is a prerequisite.

Content:
Economic agents that show bounded rationality or strategic behaviour and markets that are out of equilibrium pose serious problems to traditional economic modelling techniques.

This course introduces the students to the concept of agent based modelling which allows addressing these issues.

After presenting general agent based models in economics, we focus mainly on modelling the design of electricity markets.

Intended Learning Outcomes:
The students learn to understand the concept of agent based modelling, get to know important agent based models and learn how to apply them appropriately. Students will also learn to implement, verify and validate basic agent based models in the programming language NetLogo.

Teaching and Learning Methods:
The course is split into a lecture part which introduces students to the basic theoretical background, a practical part in the computer room, where students learn to program in Netlogo, and weekly assignments for self-study at home.

Media:

Reading List:

Responsible for Module:
Johannes Schmidt johannes.schmidt@boku.ac.at

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

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

Module Description

CS0034-2: Accredited Module 5 ECTS | Anerkanntes Modul 5 ECTS

Version of module description: Gültig ab winterterm 2020/21

Module Level:	Language:	Duration:	Frequency:
Credits:* 5	**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

CS0034-3: Accredited Module 5 ECTS | Anerkanntes Modul 5 ECTS

Version of module description: Gültig ab summerterm 2021

Module Level:	Language:	Duration:	Frequency:
Credits:* 5	**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

CS0034-4: Accredited Module 5 ECTS | Anerkanntes Modul 5 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	Language:	Duration:	Frequency:
Credits:* 5	**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

CS0034-5: Accredited Module 5 ECTS | Anerkanntes Modul 5 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 5	**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

CS0034-6: Accredited Module 5 ECTS | Anerkanntes Modul 5 ECTS

Version of module description: Gültig ab winterterm 2023/24

Module Level:	Language:	Duration:	Frequency:
Credits:* 5	**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

CS0034-7: Accredited Module 5 ECTS | Anerkanntes Modul 5 ECTS

Version of module description: Gültig ab winterterm 2023/24

Module Level:	Language:	Duration:	Frequency:
Credits:* 5	**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

CS0034-8: Accredited Module 5 ECTS | Anerkanntes Modul 5 ECTS

Version of module description: Gültig ab winterterm 2023/24

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 5	**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

CS0034-9: Accredited Module 5 ECTS | Anerkanntes Modul 5 ECTS

Version of module description: Gültig ab winterterm 2023/24

Module Level:	Language:	Duration:	Frequency:
Credits:* 5	**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

CS0035: Principles and Methods of Synthetic Biology | Principles and Methods of Synthetic Biology

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	**Language:** English	**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:
Achievement of the desired learning objectives will be verified in a written final exam (90 minutes). In the exam, the students demonstrate that they know, understand and can explain the key concepts and methods of synthetic biology. The students will also demonstrate that they are able to make predictions of the functions of synthetic gene regulatory circuits and that they can discuss risks and benefits of synthetic biology applications.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Molecular biology and genetics

Content:
- History and principles of synthetic biology
- Gene synthesis and large-scale DNA assembly
- Synthetic gene circuits
- CRISPR/Cas tools and applications
- Sensors and actuators
- Top-down and bottom-up construction of artificial cells
- Examples of synthetic biology applications in medicine, sustainable biomanufacturing, and environmental sensing and remediation
- Ethical considerations and ways to address them, potential impacts of synthetic biology on environment and society

Intended Learning Outcomes:
After successful participation in the module, students are able to explain key concepts of synthetic biology like standardization of biological parts and rational design of new biological functions. They can describe key methods and applications of synthetic biology. Furthermore, students understand the principles of regulatory circuit design and are able to predict the functions of synthetic circuits. They are able to discuss synthetic biology applications, for example in sustainable bioproduction. They are also able to discuss ethical considerations and to identify risks and benefits in synthetic biology experiments.

Teaching and Learning Methods:
The contents of the lectures are conveyed by a talk of the lecturer based on slide-supported presentations. The blackboard will be used to explain complex relationships. The content of the lecture with be supplemented by self-study of literature on synthetic biology applications that is provided to students. Synthetic biology applications and their ethical considerations will be actively discussed by students during the lecture to promote critical reflection.

Media:
Slides, whiteboard

Reading List:
The material in the lecture is sufficient for learning and is provided in the lecture.

Responsible for Module:
Prof. Henrike Niederholtmeyer

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

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

Module Description

CS0035BOK: Entrepreneurship and innovation (incl. patent licensing) | Entrepreneurship und Innovation (inkl. Patentwesen)

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**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

CS0036BOK: BOKU: Resource and Environmental Economics | BOKU: Resource and Environmental Economics [CS0036BOK]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Introductory economics and concepts of sustainability. Students are provided with refreshment slides/material in BOKUlearn and a short self-assessment quiz.

Content:
1. Principles of welfare economics;

2. Environmental Economics (Concept of Externalities: Environmental Targets and Policy Instruments);

3. International Environmental problems (Economic analysis of Climate Change, Biodiversity)

4. Economics of renewable and non-renewable Resources;

5. Irreversibility, Risk, and Uncertainty

Intended Learning Outcomes:
The Course shoul help

* to develop a strong understanding of the fundamental principles of environmental and resource economics;

* to strengthen the ability to read and synthesize papers in applied economics;

* to foster creative and independent thinking about problems in the area of environmental and resource.

Teaching and Learning Methods:
class lecture

Media:

Reading List:
Recommended Reading
Perman, Roger, Yue Ma, Michael Common, David Maddison and James McGilvray (2011): Natural Resource and Environmental Economics. 4thedition. Pearson Education Limited, Edinburgh Gate. (see library)

Responsible for Module:
BOKU Karner Katrin Institut für Nachhaltige Wirtschaftsentwicklung

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

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

Module Description

CS0037: Solid-state Physics | Festkörperphysik

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 course will be evaluated in a 90 minute written exam.
In the examination, students shall answer, for different scenarios, questions with increasing comprehension depth. This ensures that they possess fundamental knowledge of solid-state physics, as well as the ability for its application.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Physics and mathematics

Content:
This module covers the basics of solid-state physics, including: Makeup of solid matter, lattice vibrations, band models, magnetic ordering, as well as aspects of interface physirs. A particular focus will be on the interaction of electromagnetic waves with solid bodies.

Intended Learning Outcomes:
Upon completion of the course, students will be able to reproduce the known atomic arrangements in solids. They will be able to apply quantum mechanical principles to quantify energy levels of particles and atoms with boundary conditions, as well as the basics of bonding theory. They are able to set up energies of lattices using mathematical approaches. They understand the structural causes of the most important absorption, scattering and diffraction processes of electromagnetic waves and can explain the quantities and electronic structures.

Teaching and Learning Methods:
The contents of the lecture and exercise shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics.

Media:
Blackboard, slides

Reading List:
Ibach H & Lüth H. Festkörperphysik: Einführung in die Grundlagen. Springer-Verlag, (2009).
Kittel C, Gress JM & Lessard A. Einführung in die Festkörperphysik. 14, Oldenbourg München, (1969).

Responsible for Module:
Prof. Dr. Rubén D. Costa

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

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

Module Description

CS0037BOK: BOKU: Seminar in Global Change and Ecosystems | BOKU: Seminar in Global Change and Ecosystems

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 35	**Contact Hours:** 15

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

Description of Examination Method:
Evaluation of student presentation of a scientific publication. Evaluation of content and form of presentation; details will be announced in course. For a successful approbation, max. 2 missing dates will be tolerated.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basics in Ecology
advantageous: VO Global Change and Ecosystems

Content:
This seminar complements and extents the lecture VO 833.318 Global Change and Ecosystems. In the focus will be the following anthropogenic, global changes and their effects on organisms and ecosystem: greenhouse effect (atmospheric CO2 concentrations, warming, extreme weather events), ozone hole vs. surface ozone, increasing nitrogen deposition, land use change, decline in biodiversity, light pollution, noise pollution, plastic pollution, genetically modified organisms, pesticide use. In this seminar topics from the lecture will be complemented and deepened by student presentations. Great emphasis will be given on a critical discussion of the relevant scientific literature.

Intended Learning Outcomes:
1. Learn how to utilize relevant scientific data bases
2. Critical discussion of scientific literature and knowledge
3. Improvement of presentation skills

Teaching and Learning Methods:
Presentation of scientific articles

Media:

Reading List:

Responsible for Module:
Johann Gustav Zaller johann.zaller@boku.ac.at

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

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

Module Description

CS0038: Mathematics Advanced Analysis and Linear Algebra | Mathematik Vertiefung Analysis und Lineare Algebra [MathAnal]

Version of module description: Gültig ab winterterm 2020/21

Module Level:	Language:	Duration:	Frequency:
Bachelor	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:
The course will be evaluated in a 90 minute written exam.
In the examination, students shall reproduce basic theoretical concepts of real analysis in multidimensional compression, as well as adequately discuss correlations in example situations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module Mathematics

Content:
Sets and figures, structure of the number system, sequences and series of real and complex numbers, completeness of real numbers, space of continuous functions, uniform convergence, one-dimensional differentiation, Taylor's theorem, differentiation of series of functions, power series and elementary functions, rule integral or Riemann integral, improper integrals, theorem of Stokes with applications in vector analysis and topology, examples of partial differential equations and partial differential equations of the first order, existence and uniqueness theorems, basic equations of mathematical physics, boundary value problems, maximum principle and Dirichlet problem.

Intended Learning Outcomes:
After completion of the module, students know and can apply the fundamental concepts and important methods of vector analysis on manifolds and of partial differential equations. They can develop mathematical arguments in this field on their own and can express them verbally and in writing. Further, they can apply the central methods of proof and concepts of geometrical analysis and partial differential equations and know their analysitc background.

Teaching and Learning Methods:
Lecture including speech. Based on case studies fundamental mathematical methods shall be presented. General methodology shall be deducted from case studies.

Media:
Blackboard, slides

Reading List:
K. Königsberger, Analysis 1, 6. Auflage, Springer 2003.
W. Rudin, Principles of Mathematical Analysis, 2nd ed, McGraw Hill, 1964.

Responsible for Module:
Prof. Clemens Thielen

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

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

Module Description

CS0038: Advanced Mathematics 2 | Höhere Mathematik 2

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Learning outcomes are verified in a written exam. The exam consists of assignments in which the students are to demonstrate that they understand the mathematical methods conveyed as part of the module and are able to apply them to specific examples. Exam duration: 90 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Advanced Mathematics 1

Content:
Selected topics from linear algebra, vector analysis, and ordinary differential equations that are required in engineering. In particular: vector spaces, bases, linear maps, matrix representation of linear maps, functions of several variables, partial and total differentiation, Taylor expansion, basic multivariate integration, basics of ordinary differential equations. The methods are presented during the lecture and are applied to specific examples related to sustainability in the exercise classes.

Intended Learning Outcomes:
After completion of the module, students understand the fundamental concepts and important methods from vector analysis and ordinary differential equations as well as the required prerequisites from linear algebra. They are able to apply mathematical arguments in these fields independently. Moreover, they can apply the central proof techniques and concepts of vector analysis and ordinary differential equations and comprehend their mathematical background.

Teaching and Learning Methods:
Lecture using digital presentation and/or blackboard to convey contents and methods. In addtion, concrete examples are discussed in the exercise classes through independent work and group work in order to practice the adequate expression and independent application of mathematical arguments.

Media:
Blackboard, slides, exercise sheets

Reading List:
K. Königsberger, Analysis 1, 6. Auflage, Springer 2004.
K. Königsberger, Analysis 2, 5. Auflage, Springer 2004.
C. Karpfinger, Höhere Mathematik in Rezepten, 3. Auflage, Springer Spektrum 2017

Responsible for Module:
Thielen, Clemens; 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

CS0038BOK: BOKU: Medicinal and Aromatic Plants | BOKU: Medicinal and Aromatic Plants

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
Written

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
- Definitions of medicinal and spice plants, drugs, secondary substances

- Use and economic importance of medicinal plants, spice plants and essential oils

- main cultivation areas, main crops and production data

- Trade figures and business data

- Special features of medicinal plant production and spice plant production: formation, deposition and preservation of secondary plant substances

- Quality and quality-influencing factors: genetics, breeding, variety

- morphogenetic and ontogenetic variability

- Environmental influences and plant cultivation measures

- Possible applications for agrochemicals, residue problems

- Special features of "drug production": harvesting including special harvesting methods

- Post-harvest treatment and processing in the production plant (drying plants and distillation plants)

- Discussion of the CAP guidelines (Good Agricultural Practice) for medicinal and spice plant production

- Domestication of wild plants: native species: e.B. yellow gentian, arnica, yarrow, tropical and subtropical species: e.B. Ipecacuanha, Dioscorea, Lippia sp. u.a.

Arranged according to the classic secondary substance groups essential oils, glycosides and alkaloids are discussed in the individual species:

- Botany - Ingredients - Use

- Soil and climate demands, crop rotation

- Varieties and cultivation (no-till, cultivation)

- Fertilization, care, plant protection (diseases and pests)

- Harvesting, processing, quality requirements

- Essential oily species: mint, sage, thyme, marjoram, caraway, fennel, coriander, parsley, dill, chamomile, yarrow, calendula, iris, cloves, cinnamon, nutmeg, etc.

- Glycoside-containing species: foxglove, St. John's wort, medicinal rhubarb, Sennes leaves, etc.

- Alkaloid-containing species: poppy seeds, celandine, wild cherry, stecha apple, vinca, Chinese bark, etc.

- Other: coneflower; mallow, marshmallow; Aloe u.a.

Intended Learning Outcomes:

Medicinal plants and spice plants represent a small but economically interesting group of alternative crops in terms of cultivation area. Their importance has been steadily increasing in recent years. The aim of the course is to impart knowledge about the diversity of this plant group, including its ingredients (secondary plant substances) and its use as renewable raw materials. In addition, it is important to get to know the framework conditions for this branch of production, which requires a special infrastructure in the production plant, such as .B drying plants or extraction plants.

Based on the teaching content of the winter semester, special knowledge about cultivation, harvesting and processing of ingredients and use of the most important domestic, but also selected subtropical and tropical medicinal plant species and spice plant species is to be developed.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Johannes Novak Johannes.novak@boku.ac.at

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

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

Module Description

CS0039BOK: BOKU: Practical Course in Energy Engineering | BOKU: Practical Course in Energy Engineering

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 65	**Contact Hours:** 10

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

Description of Examination Method:
95% arithmetic mean of the grades of the protocols. All modules have to be completed positively. 5% counts the oral performance at the introductory lectures. In the case of insufficient preparation / negative oral examination, participation in the practical course can be denied by one of the lecturers.

Minutes submitted after the deadline will be judged negative.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge in energy technologies, but also in the fields of mechanics, fluid mechanics, thermodynamics and measurement engineering. Following LVA's are recommended for the practical course:
1) Process engineering I and II
2) Energy and environment engineering
3) Energy engineering

Content:
The practical course focuses on various energy- related topics, like energy production, energy conversion and energy consumption. The teaching content includes experiments in the field of renewable energy production, but also exercises for energy conversion (chemical, mechanical, electrical) and efficient energy consumption. In the practical course selected exercises from this themes are executed. The practical course focuses also on sustainable energy consumption. The practical course consists of 4 stations (wind turbine test facility, high temperature heat pump test bench, engine test bench and fan test bench).

For each station, a protocol has to be prepared.

Intended Learning Outcomes:
The focus of the course objects the practical application of theoretical knowledge in the areas of process engineering, energy engineering and measurement engineering.
Practical experience in case of sustainable energy production, energy conversion and energy consumption.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Jan Kotik jan.kotik@boku.ac.at

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

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

Module Description

CS0040: Material Fundamentals | Werkstoffkunde [Wkd]

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	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 course will be evaluated in a 90 minute written exam.
In the examination, students shall demonstrate their knowledge of the fundamentals of materials from all classes of materials. They shall demonstrate their ability to sketch processing routes and aspects of applications.

Repeat Examination:

(Recommended) Prerequisites:
None

Content:
This module covers the fundamental material classes, their typical properties and applications. Further, the technologically most important materials, theirMs;porii rii , ts, o

Media:
Blackboard, slides

Reading List:

Responsible for Module:
N.N.

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

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

Module Description

CS0040BOK: Enterprise Networks (Logistics) L & S | Unternehmensnetzwerke (Logistik) VL & S

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
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:

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

Module Description

CS0041: Modeling and simulation | Modellierung und Simulation [ModSim]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**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 course will be evaluated in a 90 minute written exam.
In this examination, students shall answer questions of understanding on the fundamentals of materials simulation, as well as solution pathways for given simulation tasks.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
None

Content:
This module covers the principles of the simulation of material properties. In these, the formulation of classical models will be the starting point. Computer-based methods of tracing and predicting mechanical, optical, acoustic etc. material properties will be demonstrated and exercised.

Intended Learning Outcomes:
After completion of the module, participants are enabled to identfy simulation methods for simulation tasks in materials science. Further, they can apply implementations practically.

Teaching and Learning Methods:
Lecture, exercises

Media:
Blackboard, slides

Reading List:
Kwon YW, Allen DH & Talreja R. Multiscale modeling and simulation of composite materials and structures. 47, Springer, (2008).

Responsible for Module:
Prof. Dr. Rubén D. Costa

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

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

Module Description

CS0041BOK: A first Course in CAD | CAD Kurs

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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

CS0042: Microscopy and Diffractometry | Mikroskopie und Diffraktometrie [MikDif]

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	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 course will be evaluated in a 90 minute written exam.
In the examination, students shall demonstrate their knowledge about the typical structure-determination methods applied in research and industry, including the specific implementations and the obtainable data. Based on posed scenarios, they shall demonstrate their ability to perform typical evaluation sequences.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals of materials science,
Instrumental analytics and spectroscopy

Content:
The module covers microscopic and diffractometric methods for the structural analysis of materials. In Detail, optical- and electron microscopy, in transmission- or scanning modes, respectively, and with analytic additions will be discussed. Further, methods of X-ray diffraction, in the Small- as well as Large-angle regions will be discussed. In the exercises, the evaluation methods discussed in the lecture will be practiced.

Intended Learning Outcomes:
After completion of the module, participants are enabled to name the correnponding dimensional scales that can be assessed with the discussed methods. They can give the technically achievable measurement parameters and the information that can be obtained from the data. They can permform the respective elavuations independently and know typical error sources.

Teaching and Learning Methods:
In addition to the lecture, demonstrations will be carried out at the machines. Problems will be solved cooperatively to deepen the knownledgge about microscopy and diffractometry.

Media:
Blackboard, slides

Reading List:

Responsible for Module:
Dr. Daniel van Opdenbosch

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

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

Module Description

CS0042BOK: Design of Experiments E | Statistische Versuchsplanung UE

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
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

CS0043: Material testing | Materialprüfung [MaterPrüf]

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**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 course will be evaluated in a 90 minute written exam.
In the examination, students shall be able to name the material testing methods applied in industry and research. Based on this, they shall be able to solve testing tasks, using the appropriate methods.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Materials fundamentals,
Technical mechanics elastostatics

Content:
The module covers material testing procedures from the fields of nondestructive, classical and experimental material testing. Methods applying ultrasound- and laserreflectometry, X-ray diffractometry, mechanical testing, hardness determinations, materialography, as well as methods for the determination of chemical compositions are part of this lecture.

Intended Learning Outcomes:
After completion of the module, the participants shall be able to name the proper material testing method for a given material scientific or testing technological task. They can name the properties and suitabilities of the applied methods and be able to trace them to the mechanisms of the respective methods.

Teaching and Learning Methods:
Lecture including speech. Based on case studies fundamental mathematical methods shall be presented. General methodology shall be deducted from case studies.

Media:
Blackboard, slides

Reading List:
Langenberg K-J, Marklein R & Mayer K. Theoretische Grundlagen der zerstörungsfreien Materialprüfung mit Ultraschall. Oldenbourg Verlag, (2009).
Müller EAW. Handbuch der zerstörungsfreien Materialprüfung. 3, Oldenbourg, (1959).
Weißbach W. Werkstoffkunde: Strukturen, Eigenschaften, Prüfung. Springer-Verlag, (2010).
Fink K & Rohrbach C. Handbuch der Spannungs-und Dehnungsmessung. VDI verlag, (1958).

Responsible for Module:
N.N.

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

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

Module Description

CS0043BOK: Literature Research | Literaturrecherche und Informationskompetenz - Schlüsselqualifikation für das wissenschaftliche Arbeiten VU

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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

CS0044: Project work | Projektarbeit [ProArb]

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**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 learning outcome is determined in a graded report, as well as a presentation of the results. The report should be laid out according to the rules of writing a scientific paper, including the derivation of the scientific question from the literature, the establishment of a hypothesis to be examined, a test and an analysis of the data obtained. The presentation should summarize the methods and key findings.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
In the project work, students should independently pursue a scientific question. Most importantly, the steps of the scientific method should be practiced. The steps, including literature research, hypothesizing, planning and performing the work, as well as analyzing the results and presenting them, should be carried out in accordance with current scientific practice.

Intended Learning Outcomes:
After having participated in the module, students are enabled to plan project works and critically evaluate their results. Further, they can apply this knownledge to new tasks. They are enabled to document, interpret and summarize project works and their results in written form.

Teaching and Learning Methods:
Tutored individual practical work

Media:

Reading List:
Technical literature related to mentioned topics

Responsible for Module:
N.N.

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

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

Module Description

CS0044BOK: BOKU: Procedures of Plant Production in Organic Agriculture I | BOKU: Procedures of Plant Production in Organic Agriculture I

Version of module description: Gültig ab winterterm 2022/23

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

CS0045: Inorganic, nonmetallic materials | Anorganisch-nichtmetallische Werkstoffe [AonmWerk]

Glass and ceramics

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**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 course will be evaluated in a 90 minute written exam.
In this examination, students shall demonstrate their ability to describe the mode of production, as well as the properties, of inorganic nonmetallic materials for given applications. The questions shall be answered freely, or with the aid of sketches.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
This module covers the production and the application-relevant typical properties of important inorganic-nonmetallic materials. These include the mechanical, thermal and process technical properties. Further, special characteristics and applications well be covered, for example piezo-, refractory- and thermoshock resistant ceramics, and ceramic dielectrica.

Intended Learning Outcomes:
After completion of the module, students will be able to name typical production routes and properties of inorganic-nonmetallic materials. They can reproduce the requirements towards-, and the properties of technologically relevant inorganic and nonmetallic materials. They can trace these properties to structural characteristics of the materials. Finally, they can name the appropriate, statistically relevant testing methods and evaluatue their results.

Teaching and Learning Methods:
Lecture

Media:
Blackboard, slides

Reading List:
Doremus RH. Glass science. Wiley, (1973).
Chang YM, Birnie III D & Kingery WD. Physical ceramics. (1997).
Uhlmann DR, Bowen HK & Kingery WD. Introduction to Ceramics. (1976).
Uhlmann DR & Kreidl NJ. Glass--science and technology. Academic Press, (1980).
Munz D & Fett T. Ceramics: mechanical properties, failure behaviour, materials selection. 36, Springer Science & Business Media, (2013).

Responsible for Module:
N.N.

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

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

Module Description

CS0045BOK: BOKU: Global Waste Management I | BOKU: Global Waste Management I

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**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

CS0046: Fundamentals und technology of metals | Grundlagen und Technologie der Metalle [GruTeMet]

Version of module description: Gültig ab winterterm 2020/21

Module Level:	**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 course will be evaluated in a 90 minute written exam.
In the exam, students shall answer questions freely, or based on sketches. They shall demonstrate that they are able to present production- and property profiles of metallic materials for given applications.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
The module covers the physico-chemical basics of the makeup and the resulting properties of metals. For technologically relevant metals, production routes, testing methods and applications will be shown.

Intended Learning Outcomes:
After completion of the module, students are able to name the technologically most relevant metallic materials. They can evaluate production routes based on their applicability, explain testing methods and name applications of the discussed materials.

Teaching and Learning Methods:
Lecture

Media:
Blackboard, slides

Reading List:
Ilschner B & Singer RF. Werkstoffwissenschaften und Fertigungstechnik. Springer, (2005).
Sauerwald F. Lehrbuch der Metallkunde des Eisens und der Nichteisenmetalle. Springer-Verlag, (2013).
Masing G. Lehrbuch der allgemeinen Metallkunde. Springer-verlag, (2013).

Responsible for Module:
N.N.

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

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

Module Description

CS0046: Fundamentals and Technology of Metals | Fundamentals and Technology of Metals [FUNMETAL]

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 course will be evaluated in a 90 minute written exam.
In the exam, students shall answer questions freely, or based on sketches. They shall demonstrate that they are able to present production- and property profiles of metallic materials for given applications.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
The module covers the physico-chemical basics of the makeup and the resulting properties of metals. For technologically relevant metals, production routes, testing methods and applications will be shown.

Intended Learning Outcomes:
After completion of the module, students are able to name the technologically most relevant metallic materials. They can evaluate production routes based on their applicability, explain testing methods and name applications of the discussed materials. Through case studies, students are prompted to select materials for specific application scenarios and justify their choice based on manufacturing and property profiles.

Teaching and Learning Methods:
Lecture and Seminar

Media:
Blackboard, slides

Reading List:
Materials Science and Engineering: An Introduction" by William D. Callister Jr. and David G. Rethwisch
"Physical Metallurgy Principles", Fourth Edition, by Reza Abbaschian and Robert E. Reed-Hill

Responsible for Module:
Prof. Marc Ledendecker

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

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

Module Description

CS0046BOK: BOKU: Waste Management Seminar | BOKU: Waste Management Seminar

Version of module description: Gültig ab winterterm 2022/23

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:

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

Module Description

CS0047: Nanoscale and disperse materials | Nanoskalige und disperse Materialien [NanoDispMater]

Versio

Media:
Blackboard, slides

Reading List:
Dörfler, Hans-Dieter. Grenzflächen und kolloid-disperse Systeme: Physik und Chemie. Springer, 2002.

Responsible for Module:
N.N.

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

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

Module Description

CS0047BOK: ELLS Summer School on Bioeconomy | ELLS Summer School on Bioeconomy

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**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:

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

Module Description

CS0048: Electrical engineering materials | Werkstoffe der Elektrotechnik [WerkElTech]

Version of module description: Gültig ab winterterm 2020/21

Module Level:	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 course will be evaluated in a 90 minute written exam.
In hte examination, students shall answer questions of understanding on electric and alactronic material properties. Based on this understanding, they shall evaluate materials, based on the relevatn parameters, for exemplary application profiles.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
This module covers materials in electrical and electronics engineering. These encompass conductors, superconductors, dielectrica, as well as semiconductors. Further, relevant components constructed fom these materials and their manner of construction will be discussed. Correlations between the relevant material properties and the functions of th components will be shown.

Intended Learning Outcomes:
After completion of the module, students are enabled to explain correllations between structure and properties of materials, for applications in electrical engineering. They can show processing routes for such materials and name materials that are fitting for given applications.

Teaching and Learning Methods:
Lecture

Media:
Blackboard, slides

Reading List:
Fasching GM. Werkstoffe für die Elektrotechnik: Mikrophysik, Struktur, Eigenschaften. Springer-Verlag, (2005).
Münch W. Werkstoffe der Elektrotechnik. 11, Springer-Verlag, (2013).

Responsible for Module:
N.N.

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

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

Module Description

CS0048BOK: Future Energy Supply Depending on Resource Availability | Zukünftige Energieversorgung in Abhängigkeit der Ressourcenverfügbarkeit

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
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

CS0049: Production engineering | Fertigungstechnik

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**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 course will be evaluated in a 90 minute written exam.
In this examination, students shall solve different questions on production, based on examples. This ensures that students can not only reproduce the relevant production steps, but are also able to apply them for a comprehensive problem-solving approach."

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
This module covers the technologically most important production processes and its subdivisions of primary shaping, forming, joining and separating. Classical as well as novel computer-based processes are covered.

Intended Learning Outcomes:
After completion of the module, students are able to sketch sequences of production steps. Further, they are enabled to assess their functional and economical aspects, as well as aspects of sustainability.

Teaching and Learning Methods:
Lecture

Media:
Blackboard, slides

Reading List:

Westkämper E & Warnecke H-J. Einführung in die Fertigungstechnik. Springer-Verlag, (2013).
Fritz AH & Schulze G. Fertigungstechnik. 8, Springer, (1998).

Responsible for Module:

N.N.

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

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

Module Description

CS0049BOK: Communication, Information and Participation | Kommunikation, Information und Partizipation

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
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

CS0050: Rheology and tribology | Rheologie und Tribologie [RheTrib]

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**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 course will be evaluated in a 90 minute written exam.
In the examination, students shall demonstrate their knowledge of the physical bases of rheology and tribology. Based on fundamental correlations between material strucutring and rheologic and tribologic properties, they shall outline specific correlations, und execute exemplary evaluations of measurement data."

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
The module covers the basic correlations between the structural makeup and the rheological properties of materials. Measurement methods are part of this module as well. The fundamentals of tribologic systems, methods of assessment and their technological relevance form the second part of the course contents.

Intended Learning Outcomes:
After completion of the module, participants are enabled to name methods to determine the most important rheological and tribological material properties, and to discern them, based on their application purpose and their properties. Further, they can trace rheological nd tribological phenomena to the material structures in explicitly assessed systems.

Teaching and Learning Methods:
Lecture

Media:
Blackboard, slides

Reading List:
Yip-wah C & Miyoshi K. Surface diagnostics in tribology: Fundamental principles and applications. 1, World scientific, (1993).
Macosko CW & Larson RG. Rheology: principles, measurements, and applications. (1994).
Barnes HA, Hutton JF & Walters K. An introduction to rheology. 3, Elsevier, (1989).
Halling J. Introduction to tribology. (5), Taylor & Francis Group, (1976).

Responsible for Module:
N.N.

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

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

Module Description

CS0050BOK: Soil Microbiology | Bodenmikrobiologie

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
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

CS0051: Corrosion and surface technology | Korrosion und Oberflächentechnik [KorrOb]

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	**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 course will be evaluated in a 90 minute written exam.
In the examination, students shall demonstrate their basic knowledge of corrosion mechanisms in questions of understanding. Based on this, their ability to transfer this knowledge to technological methods for the avoidance of corrosion will be evaluated.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
This course provides an initial overview of the exciting field of corrosion. This course will provide the fundamentals to understand why corrosion is important, the social consequences that can arise from corrosion, the challenges and the economic consequences will be discussed. A sustainable approach to preventing corrosion will be discussed through the use of environmentally friendly coating materials and processes and minimizing waste and emissions. In addition, corrosion prevention can be achieved through the use of materials with longer service life and higher corrosion resistance.

Students will learn in the lecture:
- Electrochemical fundamentals
- Thermodynamics of electrochemistry and corrosion
- Pourbaix diagrams
- Kinetics of corrosion
- Involved reactions

- Passivity, immunity, dissolution
- Different types of corrosion
- Protective mechanisms
- Sustainability in corrosion research

Intended Learning Outcomes:
After completion of the module, students are enabled to explain the fundamental mechanisms of corrosion of engineering materials. They can name countermeasures, and explain their working mechanisms, as well as typical procedures for the treatment of material surfaces.

Teaching and Learning Methods:
Lecture + Exercise

Media:
Blackboard, slides

Reading List:
- Introduction to Corrosion Science by Edward McCafferty
- Corrosion Science and Engineering by Pietro Pedeferri
- Corrosion Understanding the Basics by J. R. Davis

Responsible for Module:
Marc Ledendecker

Courses (Type of course, Weekly hours per semester), Instructor:
Corrosion and Surface Technology (Vorlesung mit integrierten Übungen, 4 SWS)
Ledendecker M [L], Ledendecker M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0051: Corrosion and Surface Technology | Corrosion and Surface Technology [KorrOb]

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:** 60	**Contact Hours:** 60

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

Description of Examination Method:
The learning outcome is determined by a 90-minute written examination.
In this exam, the students are required to demonstrate their knowledge of corrosion mechanisms through comprehension questions. Building on that, the ability to apply this knowledge to technical methods for corrosion prevention will be assessed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
This course provides an initial overview of the exciting field of corrosion. This course will provide the fundamentals to understand why corrosion is important, the social consequences that can arise from corrosion, the challenges and the economic consequences will be discussed. A sustainable approach to preventing corrosion will be discussed through the use of environmentally friendly coating materials and processes and minimizing waste and emissions. In addition, corrosion prevention can be achieved through the use of materials with longer service life and higher corrosion resistance.

Intended Learning Outcomes:
After completion of the module, students are enabled to explain the fundamental mechanisms of corrosion of engineering materials. They can name countermeasures, and explain their working mechanisms, as well as typical procedures for the treatment of material surfaces.

Teaching and Learning Methods:
The module consists of a lecture with integrated exercises. The learning content is conveyed through lectures. In the integrated exercises, students work on individual questions and present their solutions.

1) Lectures:
- Purpose: Lectures provide the essential theoretical foundation in sustainable energy materials, covering key topics like basic corrosion, corrosion protection, etc.
- Approach: Interactive and structured with clear explanations, visual aids, and real-world examples, lectures often include brief in-class exercises to reinforce understanding.
- Outcome Alignment: Lectures support learning outcomes related to understanding and explaining core concepts, while integrated exercises help students begin to apply and analyze these ideas.

2) Exercises and Problem-Solving Sessions:
- Purpose: These sessions reinforce lecture material, allowing students to practice problem-solving, apply theory to real-world scenarios, and deepen their understanding.
- Approach: A mix of individual and collaborative exercises, including problem sets, with guidance from instructors to support learning.
- Outcome Alignment: Exercises align with outcomes related to applying, analyzing, and evaluating knowledge, preparing students for advanced tasks in projects and labs.

Media:
1) Presentation Slides:
• Purpose: Presentation slides will be the primary medium for delivering content during lectures. They will be designed to visually complement the spoken content, providing clear and concise explanations of key concepts, diagrams, equations, and real-world examples.
• Usage: Slides will be used to illustrate complex ideas in electrochemistry, corrosion and corrosion protection, helping students to follow along and understand the material more effectively. Key points, equations, and visual aids will be highlighted to enhance comprehension.
• Accessibility: All slides will be made available to students before or after the lectures via the course's online platform, allowing for review and study at their own pace.
2) Online Learning Platform:
• Purpose: The online learning platform (e.g., Moodle) will serve as the central hub for course materials, communications, and assessments. It will facilitate a blended learning approach, integrating various media forms into a cohesive learning experience.
• Usage: The platform will host lecture slides, videos, reading materials, quizzes, and assignments. It will also be used for discussion forums where students can ask questions and engage in peer learning. This platform supports continuous access to resources and enables students to manage their learning effectively.
• Interactivity: Features such as quizzes, polls, and discussion boards will allow students to interact with the material and with each other, enhancing engagement and reinforcing learning.
3) Textbooks and Research Articles:

• Purpose: Textbooks and scholarly articles provide in-depth coverage of theoretical concepts and the latest research developments in the field. These resources are essential for supporting lecture content and offering additional perspectives on topics covered in the course.
• Usage: Core textbooks will be recommended for fundamental concepts, such as corrosion science. Research articles will be assigned to provide insights into recent advancements and emerging trends in corrosion. These readings will complement lecture content and form the basis for exercises and discussions.
• Depth: By engaging with these texts, students will deepen their understanding of the material and develop critical thinking skills, particularly in evaluating new research and technological developments.

Reading List:
- Introduction to Corrosion Science by Edward McCafferty
- Corrosion Science and Engineering by Pietro Pedeferri
- Corrosion Understanding the Basics by J. R. Davis

Responsible for Module:
Ledendecker, Marc; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Corrosion and Surface Technology (Vorlesung mit integrierten Übungen, 4 SWS)
Ledendecker M [L], Ledendecker M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0051BOK: Ecology of Roots & Mycorrhiza I | Ökologie von Wurzeln & Mykorrhiza I

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
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

CS0052: Organic Chemistry | Organic Chemistry [OrgChem]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 performance test will be in the form of a written examination rendered. The students should demonstrate in the exam the understanding of the structure of organic chemical compounds and their typical reactions and chemical conversions. It will also be tested the ability to formulate reaction equations, as well as to transfer the acquired knowledge about the structure and reaction behavior of organic chemical substance groups to new chemical questions. No auxiliary means are allowed in the exam. 90 min examination time

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge of chemistry, mathematics and physics, which correspond to the basic course knowledge of the gymnasiale upper school

Content:
General principles of organic chemistry:
Structure of organic compounds, carbon-atom hybridization, important functional groups, nomenclature and structure of organic molecules, selected reactions of organic chemistry for important groups of substances including central natural substances.

Intended Learning Outcomes:
The students will know and understand the basic principles of organic chemical reactions and will be able to formulate correct organic reactions. Moreover, they will be able to apply the knowledge acquired with model reactions about chemical transformations of organic chemical substances and substance groups to answer new chemical questions.The successful participation in the module will also enable the students to participate in the practical course and the module advanced organic chemistry.

Teaching and Learning Methods:
Lectures and corresponding exercises with self analysis and workup of specific case studies. In relation to the teaching content exercise sheets are disbursed on which the students work in self-study before the tutorials. The solution and discussion takes place in the tutorials. At the postprocessing of the lecture exspecially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the structure and reaction behavior of organic chemical substance groups and practise the formulation of reaction equations.

Media:
Blackboard, presentation (using script), exercises

Reading List:
P. Vollhardt, N. Schore, Organic Chemistry, macmillan learning, 2022, ISBN:9781319392857
K.P.C. Vollhardt, N.E. Schore, Organische Chemie, Verlag VCH Weinheim

Responsible for Module:
Plumeré, Nicolas; 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

CS0052BOK: Geothermal Energy - Geological Fundamentals and Applications | Geothermal Energy - Geological Fundamentals and Applications

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
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

CS0053: Research Internship | Forschungspraktikum

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**Language:** German	**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:
Exam achievement consists of a graded practical course report about contents and results of the practical course containing at least an overview of the level of knowledge relating to the project subject as well as representation of used working methods and a representation of the results including interpretation. In a final grade quality of familiarisation with the topic of experimental work, interpretation of results and written elaboration shall be evaluated. The internship report comprises about 30 to 60 pages, depending on the topic.

Repeat Examination:
Next semester

able to document, to interpret and summarise project works and results in a meaningful way in written form.

Teaching and Learning Methods:
According to the core theme and topic, e.g. experimental equipment (laboratory), databases, libraries, subject-specific software, project and experiment design software

Media:
According to the topic, e.g. experimental equipment (laboratory), databases, libraries, subject-specific software, project and experiment design software

Reading List:
Technical literature related to mentioned topics

Responsible for Module:
Prof. Cordt Zollfrank

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Bachelor Pflichtmodul (Praktikum, 10 SWS)
Blombach B [L], Blombach B, Glawischnig E, Hädrich M, Vital S

Forschungspraktikum Bachelor Biogene Werkstoffe (Praktikum, 10 SWS)
Costa Riquelme R [L], Costa Riquelme R

Forschungspraktikum Bachelor Pflicht (Forschungspraktikum, 10 SWS)
Sieber V [L], Abbas Nia A, Al-Shameri A, Arana Pena S, Dsouza Z, Fornoni E, Friedrichs J, Fuchs A, Giustino A, Grundheber J, Hofer N, Hörnschemeyer K, Hupfeld E, Kampl L, Köllen T, Liu Y, Malubhoy Z, Marosevic M, Matena F, Mayer M, Ostertag T, Raga Carbajal E, Rau M, Romeis D, Rühmann B, Scheerer J, Schieder D, Schulz M, Sieber V, Siebert D, Skopp A

Forschungspraktikum Bachelor BVT (Forschungspraktikum, 10 SWS)
Zavrel M [L], Beerhalter D, Borger J, Dsouza V, Geisler N, Marino Jara J, Oktay I, Stegemeyer U, van der Walt H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0053BOK: Selected Lectures in International Agricultural Economics | Selected Lectures in International Agricultural Economics [CS0053BOK]

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
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

CS0054: Bachelor's Thesis | Bachelor's Thesis

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 360	**Self-study Hours:** 180	**Contact Hours:** 180

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

Description of Examination Method:
The Bachelor's Thesis is a three-month thesis in which students deal scientifically with a study program specific topic. For this purpose, the students formulate the state of scientific knowledge and discourse in writing and develop a specific question based on this. Students deal with this topic with the technical and methodological knowledge acquired during their studies. The module is completed with the preparation and positive evaluation of the Bachelor´s Thesis (depending on selection of topics 10 to 100 pages).

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
120 credits, including all compulsory modules from the first four semesters, according to the module plan of the respective bachelor's program

Content:
consolidation of the knowledge of a specific biotechnological / bioeconomic topic which is arbitrary in consultation with the supervisor / consolidation of practical skills in the lab / presentation of a research-based topic in the field of biotechnology / bioeconomy

Intended Learning Outcomes:
After completion of the module, the students are able to work self-reliant on simple scientific problems on the basis of scientific methods and analytical thinking. The can present their results in a conclusive way, are able to discuss and to draw conclusions.

Teaching and Learning Methods:
During the Bachelor´s Thesis, the students work on a scientific problem. At this juncture amongst others literature research as well as lab work and presentations are used. The actual teaching and

learning methods depend on the respective problem and have to be discussed with the supervisor for each single case.

Media:
Specialist literature, software and so on

Reading List:
in consultation with the supervisor

Responsible for Module:
Prof. Cordt Zollfrank

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

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

Module Description

CS0054BOK: Seminar National and International Food Safty Autorities | Seminar National and International Food Safty Autorities

Version of module description: Gültig ab winterterm 2022/23

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	summer semester
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

CS0055: Fundamentals of material science | Grundlagen der Materialwissenschaften [GruMaterWiss]

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor	**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 course will be evaluated in a 90 minute written exam.
In the examination, students shall answer comprehension questions about the fundamentals of structural setup of electronic structure of matter. Based on these fundamentals, they shall describe relationships to external mechanical, optical, and semiconductor properties of materials. They shall demonstrate their ability to determine and mathematically derive appropriate metrics.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of geometry, basic knowledge of chemistry, basic knowledge of mathematics

Content:
The module provides knowledge of concepts and methods of materials science practice for characterization and evaluation. Students learn fundamental relationships between structure and properties. As the most important complex, the influence of atomic and microstructural structure on the optical and electrical properties of materials is covered. In this context and beyond, students learn the most important relationships between electronic structure and bonding theory with optical, electronic and thermal properties.

Intended Learning Outcomes:
After successful completion of the module, students are able to name aspects of the evaluation of a material with regard to its electronic structure as well as optical, electronic semiconductor and thermal properties. They are able to explain the common methods for the evaluation of the most important material properties.

Teaching and Learning Methods:
Lecture and Exercise

Media:
Blackboard, slides

Reading List:
Hornbogen E, Eggeler G, Werner E: Werkstoffe. Aufbau und Eigenschaften von Keramik-, Metall-, Polymer- und Verbundwerkstoffen. Springer ISBN 978-3-642-22560-4 (Druck) ISBN 978-3-642-22561-1 (Elektronisch)
Türk, O: Stoffliche Nutzung nachwachsender Rohstoffe: Grundlagen - Werkstoffe - Anwendungen. Springer ISBN 978-3-834-81763-1 (Druck), ISBN 978-3-8348-2199-7 (Elektronisch)
Ilschner B, Singer R: Werkstoffwissenschaften und Fertigungstechnik. Springer ISBN: 978-3-642-01733-9 (Druck) 978-3-642-01734-6 (Elektronisch)

Responsible for Module:
Prof. Dr. Rubén D. Costa

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen der Materialwissenschaften - Übung (Übung, 2 SWS)
Costa Riquelme R [L], Atoini Y, Costa Riquelme R, Zieleniewska A

Grundlagen der Materialwissenschaften - Vorlesung (Vorlesung, 2 SWS)
Costa Riquelme R [L], Atoini Y, Costa Riquelme R, Zieleniewska A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0055BOK: Lecture and Seminar Open Innovation Strategies | Lecture and Seminar Open Innovation Strategies

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
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.

CS0056

Intended Learning Outcomes:
After attending the module, the students are able to evaluate the application of enzymes in different chemical and technical processes. They are able to understand and to reflect the behavior and the limitations of enzymes within those processes and they are able to plan sensible strategies to establish chemical conversions biocatalytically, as well as suggesting technical scenarios for new biocatalytical processes.

Teaching and Learning Methods:
The module consists of a lecture (2 SHPW). The lecturer uses PowerPoint slides and board writings to convey theoretical groundwork and technical important aspects for the application of enzymes in industrial processes. The PPT slides are supplied online after each lecture.

The exercise is carried out with the help of PowerPoint presentations and blackboard writing. Students present any homework on the blackboard or with the help of a PowerPoint presentation. The exercise serves to deepen the topics covered in the lecture and serves the students during exam preparation. The topics of the lecture will be taken up and explained and illustrated by means of exemplary exam questions to make it easier for the students to prepare for the exam.

Media:
The lecture presentation will be held with powerpoint and adobe acrobat reader and black board writings. The students will gain access to all of the necessary slides via moodle.

Reading List:
Reinhard Renneberg, Darja Süßbier, Biotechnologie für Einsteiger, 3. Auflage, Spektrum Verlag Heidelberg 2010
A. Liese, K. Seelbach, C. Wandrey, Industrial Biotransformations, Wiley-VCH, 2006
Wolfgang Aehle, Enzymes in Industry, Wiley-VCH-Verlag Weinheim, 2007,
Drauz, Gröger, May, Enzyme Catalysis in organic Synthesis 3rd Ed., Wiley-VCH, 2012
Klaus Buchholz, Volker Kasche, Uwe T. Bornscheuer, Biocatalysts and Enzyme Technology, Wiley-VCH, 2005
Wim Soetaert, Erick J. Vandamme, Industrial Biotechnology, Wiley-VCH, 2010

Responsible for Module:
Volker Sieber (sieber@tum.de) Jörg Carsten (Joerg.carsten@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Übungen zur Vorlesung Technische Biokatalyse (Übung, 1 SWS)
Sieber V [L], Köllen T

Technische Biokatalyse (Vorlesung, 2 SWS)
Sieber V [L], Sieber V, Köllen T
For further information in this module, please click campus.tum.de or here.

Module Description

CS0056BOK: Lecture and Exercise Intercultural Communication | Lecture and Exercise Intercultural Communication

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
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

CS0057: Enzyme Engineering | Enzym Engineering

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 135	**Contact Hours:** 75

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

Description of Examination Method:
The intended learning results of the lecture will be checked in the form of a 90-minute exam by comprehension questions on topics of molecular biological and protein chemical approaches to the optimization of enzymes (approved tool: pocket calculator). This should ensure that the acquired knowledge can be applied and transferred to similar questions.

The intended learning results of the lecture will be checked in the form of a 90-minute exam by comprehension questions on topics of molecular biological and protein chemical approaches to the optimization of enzymes (approved tool: pocket calculator). This should ensure that the acquired knowledge can be applied and transferred to similar questions.
The learning outcomes of the practical course will be reviewed in the form of a report, in which the students will demonstrate that they have understood the main contents of the practical course (implementation, evaluation and interpretation of the results obtained). The report is accompanied by a 30-minute presentation in which the presentation of the teaching content and thus the understanding of the learning outcomes can be checked during the practical course.
60% of the written exam and 40% of the report are included in the overall evaluation of the module.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites for successful participation are knowledge of technical biocatalysis, the basics of microbiology, molecular bacterial genetics, protein chemistry and bioinformatics.

Content:
In the lecture and the accompanying seminar the molecular biological and protein-chemical approaches for the optimization of enzymes are to be obtained in particular over variation of the primary structure. Essential contents are: Analysis of limitation at the molecular level, rational

methods, computer-aided methods, evolutionary and combined methods, high-throughput methods and robotics.

The practical course is intended to provide practical instruction in molecular biological and protein-chemical methods for optimizing enzymes using two relevant examples:
1. Rational/computer-aided approach - site-directed (random) mutagenesis based on sequence comparisons, structural analyses and computer models.
2. Purely evolutionary approach: site-directed, randomized mutagenesis. Both approaches use state-of-the-art assay methods. In addition, the optimized enzymes are used for simple technical conversions (enzyme immobilization, product quantification, enzyme recycling).

Intended Learning Outcomes:
After the participation in the lecture, the students are able to show options for technically limited enzymes, to improve these enzymes, to estimate the necessary effort and have the theoretical ability to implement these improvements methodically in the following practical course Enzyme Optimization.
After the participation in the practical course, the students are able to carry out different methods for enzyme optimization and to carry out the essential elements (production of variants, assay construction and screening, operation of necessary hardware) practically.

Teaching and Learning Methods:
In the lecture, the topics "molecular biological and protein-chemical approaches for the optimization of enzymes" will be treated with the help of PPT lectures and blackboard notes. A seminar, in which the students present current literature on topics of the lecture, should internalize and deepen the methods and procedures for the optimization of enzymes presented in the lecture by the presented examples.
The slides of the lecture and the seminar lectures will be made available online after the respective event.

The practical course following the lecture offers concrete possibilities for learning and applying standard methods used in enzyme optimization, which are carried out by the students themselves.

Media:
Black board and PPT-presentations are used. The PPT-slides will be available for the students in advance or shortly after the lecture session was held. The students will gain access to all of the necessary slides via moodle.

Reading List:
Recommendations:
"Directed Enzyme Evolution: Screening and Selection Methods” (Methods in Molecular Biology) and “Directed Evolution Library Creation: Methods and Protocols” (Methods in Molecular Biology), both Frances H. Arnold, George Georgiou (publisher), Springer, Berlin
“Protein Engineering Protocols” (Methods in Molecular Biology), Katja M. Arndt and Kristian M. Muller (publisher), Springer, Berlin.

Responsible for Module:
Volker Sieber (sieber@tum.de) Jörg Carsten (Joerg.Carsten@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

CS0057BOK: Lecture and Exercise Organisational Behaviour and Gender Issues | Lecture and Exercise Organisational Behaviour and Gender Issues

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:*	**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

CS0058: CFD - Simulation for Energy Systems | CFD - Simulation for Energy Systems [A-CFD]

Version of module description: Gültig ab summerterm 2023

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:
In modern CFD programs, complex mathematical models are made accessible to the user in a simple form. Nevertheless, it is crucial for the correct application of these models to know the basic, theoretical background. The examination performance therefore is a project report. The students prove that they can answer questions about the theory of CFD in writing and solve small computational problems. The students thus show that they are capable of implementing a flow simulation in CFD programs and interpreting the results obtained.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites for the successful participation is knowledge about
Fluid Dynamics

Content:
The course provides basic knowledge about the underlying theory of CFD simulation to enable students to conduct simple workflows within the CFD simulation software. Simplifications and models for solving the conversion equations of fluid dynamics - mass, impulse and energy - is shown. Furthermore, meshing and setting up useful boundary conditions for solving the flow equations is presented. After solving the CFD problem, validation and presentation of the results by means of flow profiles and animations will be done. The setup of a CFD model including geometric preparation of a model, meshing, pre-processing, solving, and post-processing will be demonstrated and carried out in the CFD software.

Intended Learning Outcomes:
After successful participation within this course, students are capable of carrying out simple workflows within the CFD simulation software (e. g. OpenFOAM, Ansys), including the preparation of a CAD model, meshing, pre-processing, solving, and post-processing. Furthermore, they gained a basic understanding of the relevant theory behind a CFD simulation software.

Teaching and Learning Methods:
The course is set up of a lecture and practical part. The lecture provides the aforementioned relevant theory underlying a CFD simulation software. The practical part includes a guided setup of a CFD model within the CFD software and an independently conducted project at the end of the semester.

Media:
Lecture, blackboard, computer/laptop

Reading List:
Ferziger, J.H.; Peric, M.: Numerische Strömungsmechanik, 1. Auflage, Springer, eBook ISBN 978-3-540-68228-8, 2008
Gersten, K.: Einführung in die Strömungsmechanik, 2. Auflage, Springer, eBook ISBN 978-3-663-14151-8, 1981
Laurien, E.; Oertel jr., H.: Numerische Strömungsmechanik, 3. Auflage, Springer, eBook ISBN 978-3-658-03145-9, 2013
Ferziger, J.H.; Peric, M.; Street, R.L.: Computational Methods for Fluid Dynamics, 4. Auflage, Springer, eBook ISBN 978-3-319-99693-6, 2019

Responsible for Module:
Matthias Gaderer gaderer@tum.de Bernhard Huber b.huber@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

CS0058BOK: BOKU: Renewable Energy Resources | BOKU: Renewable Energy Resources

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 41	**Contact Hours:** 34

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

Description of Examination Method:

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Fundamentals of physics and thermodynmacis

Content:
Energy demand and energy supply for Austria / EU. Overview of the thermodynamic fundamentals of energy conversion and introduction to the energy use (heat, electricity, fuels).
Renewable energy sources: use of solar energy for thermal use and photovoltaics, combustion calculation, thermo-chemical biomass conversion (pyrolysis, gasification, combustion, hydrothermal processes), hydropower (run-of-river, reservoir and storage power plant), geotherma energy, wind energy, biogas (anaerobic fermentation)

In the winter semester, the lecture will be offered live on the dates listed below via Zoom. Details and teaching materials can be found in the relevant BOKUlearn course.

Excursion:
It is not clear if the field trip can be provided in the winter term 2020/21. In case of cancellation a homework will be given (details can be found in the BOKUlearn course). Participation/homework contributes to the assessment of the course to 20% but is not mandatory.

Intended Learning Outcomes:
Understanding of the processes for energy utilization, competence in explaining processes and being able to compare them with one another, knowledge of thermodynamic fundamentals and physical terms

Teaching and Learning Methods:

Media:

Reading List:
Vorlesungsunterlagen werden über BOKUlearn bereitgestellt.

Responsible for Module:
Rafat Al Afif rafat.alafif@boku.ac.at

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

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

Module Description

CS0059: Advanced Seminar in Supply and Value Chain Management | Advanced Seminar in Supply and Value Chain Management

Version of module description: Gültig ab winterterm 2023/24

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 consists of a written seminar paper, implemented optimization or simulation models as well as an oral presentation & discussion. The seminar paper should cover 15-20 pages and is written in the style of current publications of peer-reviewed journal articles. Accompanied with the seminar paper models have to be implemented to conduct numerical analyses, which will be handed in as a digital appendix. At the end of the module students present their work in a 45 minutes presentation.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
One module in the field of Supply Chain Management

Content:
The objective of the module is to equip the participants with the necessary skill and tools for a successful master thesis project.

Specifically, the aim is to be able to:

- Read and understand recent research contributions
- Pursue interesting research questions
- Conduct a literature study and/or numerical study and/or implementation
- Structure and organize research methods and results
- Write a seminar paper
- Present research findings and defend them in a discussion

Intended Learning Outcomes:
The objective of the module is to equip the participants with the necessary skill and tools for a successful master thesis project.

Specifically, the aim is to be able to:

- Read and understand recent research contributions
- Pursue interesting research questions
- Conduct a literature study and/or numerical study and/or implementation
- Structure and organize research methods and results
- Write a seminar paper
- Present research findings and defend them in a discussion

Teaching and Learning Methods:
In an introductory session, the current theme of the module is explained by the lecturer and the various available seminar topics are elaborated in detail. Also information on relevant literature for the problem settings is introduced, wich forms the basis of the students' seminar papers. After the introductory session, students will work out the topic on their own, by using their abbilities of conducting literature research, mathematical modelling, programming and analyses. Throughout the whole time, they receive guidance from a supervisor of the chair. Different milestones are to be achieved at specific dates, such as a preliminary outline of the seminar paper, first research results and the final paper. Following the submission of the final paper, presentations and discussions of all students' seminar papers are conducted, usually spanning one or several days, where amongst others also presentation, moderation and discussion skills are trained.

Media:
Research paper; presentation slides

Reading List:
depending on scope of seminar

Responsible for Module:
Alexander Hübner alexander.huebner@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar in Supply and Value Chain Management (Seminar, 4 SWS)
Hübner A [L], Hübner A, Riesenegger L, Tuma N
For further information in this module, please click campus.tum.de or here.

Module Description

CS0059BOK: BOKU: Applied Biocatalysis | BOKU: Applied Biocatalysis

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 50	**Contact Hours:** 25

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

Description of Examination Method:
Oral exam.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Knowledge of enzymatic reactions, engineering and (bio-)chemistry.

Content:
Applied biocatalysis" is an advanced lecture within the specialisation of “Protein engineering and technology”; in the master study programme Biotechnology H418. This course is based on the knowledge and concepts provided in engineering, chemistry, biochemistry, and molecular biology courses. The lecture starts with a general overview on enzymatic reactions, screening and engineering of enzymes for industrial applications, followed by the basics of biochemical reaction engineering (reaction and process engineering) and general criteria for industrial enzymatic processes. In the main part of the lecture specific examples of biocatalytic synthetic reactions of oxidoreductases, transferases, hydrolases, lyases, isomerases, and ligases in the various industrial sectors are introduced, analysed and probable improvements are discussed. Finally, general rules to establish a biocatalytic process will be the drawn and the strengths and weaknesses of biocatalytic reactions will be assessed.

Intended Learning Outcomes:
After successful attendance of this lecture the participants can recall the application of enzymes for the synthesis of bulk chemicals, fine chemicals and specialities. They can differentiate between different biocatalysts and know their cosubstrate requirements and necessary auxiliary reactions. They can evaluate the usefulness and performance of equilibrium reactions, enantiomeric reactions, hydrolytic reactions, reductive reactions, oxidation reactions, oxygenation reactions,

peroxidation reactions, Bayer-Villiger reactions, formation of C-C bonds, and de-/halogenation reactions. They can identify critical mechanistic limitations of reactions and rate limiting steps, and are competent to optimise reaction conditions. Finally, participants will be able to plan biocatalytic processes based on existing industrial processes and calculate performance numbers for the comparison of processes

Teaching and Learning Methods:
class lecture
Lectures equal to 1.2 ECTS will be accompanied by the idividual study of scientific articles and review materials (0.8 ECTS). For learning and the preparation to the oral exam 1 ECTS is designated.

Media:

Reading List:

Responsible for Module:
Dietmar Haltrich (BOKU)

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

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

Module Description

CS0060: Business Game in Sustainable Management | Business Game in Sustainable Management

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:
Because of the mediation of competences and the interactive character of the module using the supply chain simulation „The Fresh Connection" several group presentations are part of the evaluation:
- Introductory presentation for a supply chain topic (30 minutes / 50% of the evaluation)
- Short presentation concerning decision alternatives within a round of the simulation (10 minutes / 20% of the evaluation)
- Presentations of the decisions made within the respective rounds of the simulation, the lessons learnt and the results (15 minutes / 30% of the evaluation)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Supply Chain Planning

Content:
The module is an innovative combination of mediation of theoretical background knowledge, practice and experience using the supply chain simulation „The Fresh Connection". The topics in detail:
- Basics and decision making in supply chain management
- Supplier Management
- Demand Management
- Capacity and Production Management
- Inventory Management and Planning
- Supply Chain Mapping and component characteristics
- Supply Chain Strategy

- Variables and KPI‘s on strategic and tactical level
- External Collaboration

Intended Learning Outcomes:
The students will obtain a practice oriented overview of basics, decisions and interrelations in supply chain management. The students will achieve the ability to understand influencing factors and consequences of supply chain decisions with the help of the simulation “The Fresh Connection“. The students will achieve the competence for autonomous academic self study and application-oriented presentation of content. A focus of the mediation of competences is on work in cross-functional teams.

Teaching and Learning Methods:
Lecture, Web-based supply chain management simulation and learning environment, self study and group work with presentation of result

Media:
Lecture, simulation software, presentations

Reading List:
Fisher, M.L. , What is the right supply chain for your product?, Harvard Business Review, March-April 1997
Christopher, M. , Logistics and Supply Chain Management, creating value-added networks, Prentice Hall, 2005
Chopra, S. and Meindl, Supply Chain Management, Pearson Education, third edition, 2007

Responsible for Module:
Alexander Hübner alexander.huebner@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

CS0060BOK: BOKU: Automation of Bioprocesses | BOKU: Automation of Bioprocesses

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 52	**Contact Hours:** 23

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

Description of Examination Method:
Continuous assessment

The lecture is split into a theoretical and a practical part. The evaluation criterion for the theoretical part is based on the assessment of involvement and active participation and represents 40% of the final grade.
The practical part is organized in form of teamwork practice. The task to be solved is an automation problem in industrial environment. This part contributes 60% to the final grade.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
Lecture

- Basics of automation, definitions, layout of a biotech plant

- Hardware: signal acquisition, interfacing, visualisation, systems hierarchy and ´architecture (field bus, smart sensors, actors)

- Design, system specification, contract specification

- Validation (QA) (GAMP)

Practical:

- Layout of vessel, I scheme, I/O list, layout system specification, contract specification

- DEMO process control software

Intended Learning Outcomes:
After successful completion of this course, students will be able to explain general bioprocess automation concepts and process control strategies as well as hardware and software solutions. Students will be able to select required hardware components and software solutions for bioprocess automation. They can define specification requirements.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Gerald Striedner (BOKU)

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

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

Module Description

CS0061: Seminar in Behavioral Economics | Seminar in Behavioral Economics

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** English	**Duration:** one semester	**Frequency:** winter/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 learning results are tested in form of a written thesis. The students write a theoretical and/or empirical thesis of a maximum of 15 pages that addresses a current research problem in the area of behavioral economics. They prove that they have understood the content of the current academic literature and are able to understand the required empirical analyses.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Behavioral Economics

Content:
After being introduced to adequate research designs in the area of beahvioral economics, students explore the academic literature on a choosen topic. The topics are typically related to human behavior in an economic context and potential behavioral interventions for more sustainable behavior.
Potential topics are:
-Green Nudges
-Social Comparison
-Choice Architecture

Intended Learning Outcomes:
After sucessful completion of the module the students are able to derive a current academic research questions and to respond to it by using the relevant literature in the area of Behavioral Economics. In addition to the required literature analysis based on peer-reviewed academic

journals, the students are able to interpret the relevant empirical analyses, to critically review studies, and to identify the potential relationship of different strands of research.

Teaching and Learning Methods:
The students will be familiarized with the basics to conduct literature reviews in the area of Behavioral Economics. Students work on a reasearch question and learn to summarize the current state of research. Thereby students learn how to critically review current research results and research designs. The students apply these contents to their own research questions in the thesis. The students present their results in front of the other seminar members, and discuss their results with the group.
The students have to write a seminar thesis in order to learn how to write an academic paper based on a relevant research questions.

Media:
Presentation, Power-Point Slides

Reading List:
Relevant research articles are provided

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

Courses (Type of course, Wee p

Module Description

CS0061BOK: BOKU: Planning and Assessment of Waste Management Systems | BOKU: Planning and Assessment of Waste Management Systems

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 51	**Contact Hours:** 24

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

Description of Examination Method:
The total grade consists of the following individual specification:

- Participation and self-dependence, small exercises: 30%
- LCA case study elaboration: 40%
- LCA case study epresentation and discussion: 30%

Continuous assessment

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
The content of the LVA Life cycle management (813.304) or similar knowledge to Life cycle Assessment, Impact categories, Assessment Methodologies... is expected.

Content:
- Introduction to the assessment of projects and plans - strategic environmental assessment (SEA) and life cycle assessment (LCA)
- Scenario development
- Details on impact assessment
- Modelling of waste treatment technologies in life cycle assessment
- Introduction to the life cycle assessment software GaBi
- Elaboration of a LCA case study using the GaBi-Software tool

Intended Learning Outcomes:
Participants are able to assess waste management measures and to use specific soft ware tools (e.g. GaBi 6.0). They know basic methods and instruments for environmental assessment and can also evaluate them practically. The participants are able to independently calculate a life cycle assessment.
They have theoretical and practical knowledge of basic methods and tools for environmental assessment (LCA) and strategic desicion-making in waste management planning

Teaching and Learning Methods:
lecture with exercises
The lecture is very similar to the procedure in reality. First, the basic scenarios of an SEA are discussed, and the LCA case studies are based on these. The calculation and presentation of the LCA results (preparation in small groups of 2-3 people) brings all participants to a comparable level of knowledge, which is necessary for the further discussion process.
The VO units are held in blocks (4 or 6 units each), each ending with a preparation for the exercises. Furthermore, pure "exercise blocks" are also carried out, which make it easier for the students to start the exercise by the presence of the lecturer. The attendance blocks correspond to 24 hours, whereby approx. 50-55 hours should be spent on the "home exercises".

Media:

Reading List:

Responsible for Module:

Module Description

CS0062BOK: BOKU: Biomaterials | BOKU: Biomaterials

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 29	**Contact Hours:** 21

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

Description of Examination Method:
Written exam

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
Elements of biomaterials · The making of – self-assembly and growth · Mechanical concepts in biomaterials · High-performance fibers: spider silk, keratin, collagen · Soft tissue – skin, cartilage, glue · Engineering with fibers: biological composite materials · Bioceramics – teeth, nacre · Art of hierarchical design 1: bone · Art of hierarchical design 2: wood · Intelligent materials – adaptive growth · Biomimetic and bio-inspired materials

Smart materials design may still be a challenge for us today, but Nature has been using it on a regular basis already ages ago. In spite of strictly limited resources and limitations imposed by environmental conditions, sophisticated biomaterials have evolved. They are specially adapted to fulfill specific tasks and are mechanically optimized. Even today, some of them still surpass artificially produced materials in many respects. In this course, selected biomaterials will be presented and their structure, mechanical properties and design strategies explained. A brief overview of experimental investigation methods and possibilities to use design principles from Nature shall be given as well.

Intended Learning Outcomes:
Students graduating from this course have basic knowledge about the design principles and properties of biological materials. They are able to describe structure and function of selected

example materials in detail, recognize common principles and draw conclusions for potential transfer of natural materials design to technical materials.

Teaching and Learning Methods:
Class lecture

Media:

Reading List:

Responsible for Module:
Helga Lichtenegger (BOKU)

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

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

Module Description

CS0063: Microeconomics | Microeconomics [Micro I]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
In the exam (written, 120 minutes) students should demonstrate their ability to adequately interpret the microeconomic concepts and apply the methods worked on in class. By means of multiple-choice-questions, which are either embedded in a context/case/scenario or require prior computation, students' capacity to apply the learned solution strategies to new settings and draw correct economic implications is assessed. A non-programmable calculator is allowed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
This course provides an introduction to basic concepts of microeconomics. To understand how a transition towards a more sustainable economy is possible we first have to understand the basic mechanisms in the economy. To this end, this lecture investigates the behavior of individual economic units, such as households, business firms, and public institutions. Another concern is how these units interact to form markets and industries. How can consumer decisions be explained and how can aggregate demand be derived from consumer choice? Which are the factors that determine the production decisions of companies? How do equilibrium prices emerge in competitive markets, how in monopoly markets? What is the effect of government interventions in markets (e.g. green taxes, price controls)? How does market power affect social welfare? Which factors lead to market failure?

Intended Learning Outcomes:
After attending this module, students will be able to describe economic tradeoffs (particularly in choice under scarcity situations of consumers and firms). Moreover, they know strategies to

solve those tradeoffs and are capable of applying them to new situations. Students are able to explain the fundamental economic mechanisms underlying specialisation and trade (particularly in view of technological progress). Students can predict how government interventions (e.g. carbon taxes, price controls) will affect simple competitive markets. They are able to explain why certain industries are prone to market concentration and how market power affects social welfare. They can distinguish which types of goods are efficiently provided on free markets and which not.

Teaching and Learning Methods:
An interactive lecture introduces essential microeconomic concepts and theories and illustrates them with the help of topical empirical examples. Classroom experiments complement the classic bird-eye's perspective by nudging students to put themselves in the positition of particular economic players, thereby requiring them to actively reflect the concepts introduced. Online surveys at the end of each chapter enable students to select which topics they would like to intensify in subsequent classes. In the accompaying exercise class, students practice, on specific problems and examples, the mathematical techniques needed to develop a deeper understanding of the economic concepts. In self-study students use the textbook to repeat the concepts introduced in class and apply them to additional examples.

Media:
Textbook, slides, exercise sheets, classroom experiments, online surveys

Reading List:
Robert S. Pindyck and David L. Rubinfeld, Microeconomics, 8th Edition, Pearson, 2013 (ISBN 13: 978-0-13-285712-3). AND Robert S. Pindyck und David L. Rubinfeld, Mikroökonomie, 8. Aufl., Pearson Studium, 2013 (ISBN-13: 978-3868941678).

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Economics I am Campus Straubing (Microeconomics) (Vorlesung, 2 SWS)
Goerg S [L], Goerg S

Economics I - Übung am Campus Straubing (Übung, 2 SWS)
Goerg S [L], Speckner M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0063BOK: BOKU: Crop Production | BOKU: Crop Production

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 52	**Contact Hours:** 23

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

Description of Examination Method:
Written and oral
There is a written exam shortly after the end of the course. It takes roughly half an hour and consists of about 15 questions in multiple choice mode or requiring very short written answers. Each question allows for an indicated number of points, which are given according to the correctness of the answer. A minimum of 50% of the points are necessary to pass. Marks are given relative to the number of marks exceeding that minimum.
Students who are not able to attend that exam are offered oral exams based on individual appointments. The questions will be selected from the previous written exam and the affiliation of marks is again related to the correctness of answers.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge in (plant) biology and physics on Matura level

Content:
Block A: Introduction to agronomy
1. Introduction
- Definition of course contents and objectives
- Arable crops and grassland as elements of agro-ecosystems
2. Historical view
3. Effects of environmental factors on field crops
4. Germination and crop establishment
5. Growth, development and yield formation
6. Crop husbandry
7. Environmental impacts of field crops

8. Systems of crop production - conventional/integrated/ecological agriculture

Block B: Fodder crops and catch/cover crops, grain crops rich in carbohydrates (cereals)
1. Botanical classification
2. Environmental needs
3. Definition, assessment and production of yield and quality
4. Crop husbandry

Block C: Grain crops rich in protein or oil; root and tuber crops; renewable resources
1. Botanical classification
2. Environmental needs
3. Definition, assessment and production of yield and quality
4. Crop husbandry

Intended Learning Outcomes:
Students acquire knowledge about field crop production with emphasis on the underlying physical, chemical and biological processes, also with view to environmental claims

Students can draw conclusions on suitable crop management practices

Students acquire detailed knowledge about environmental needs, yield, product quality and crop husbandry of important arable crop species in temperate climate zones

Teaching and Learning Methods:
Classroom lecture, assisted by moodle

Media:
course material available at BOKUlearn (Moodle)

Reading List:

Responsible for Module:
Hans-Peter Kaul (BOKU)

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

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

Module Description

CS0064: Environmental Management | Environmental Management [EM]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Written exam (90 minutes): By solving problems from the thematic field of the module students have to prove their understanding of the basics of corporate environmental management, their ability to apply environmental management methods in the field. In the solution of the problems they need to demonstrate their ability to identify and analyse environmental impacts of corporate activities, to apply the managerial toolset provided by the ISO 140000 series and the Environmental Management and Audit Scheme (EMAS) to (simplified) practical problems. In addition, they need to show that they are able to describe the application of these methods in practice based on case examples. Learning aids: pocket calculator.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The module contains units covering the following topics:
- Environmental impacts of industrial and business activities,
- Societal, economic and legal frameworks of environmental protection,
- Motivation for businesses for applying environmental management approaches and methods,
- Environmental Management Systems (e.g. ISO 14000 series, EMAS),
- Methods and tools for environmental management (indicators, reporting, life cycle assessment), and
- Recent and emerging topics in environmental management.

Intended Learning Outcomes:
Students understand basics of corporate environmental management and its relevance for companies, application potentials and their implementation. The discuss these in context of business and research, reflect it critically and derive consequences for companies and research.

Teaching and Learning Methods:
Format: Lecture with tutorial to introduce, train and deepen the contents of the module.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individual assignments and presentation

The teaching and learning methods are combinded specifically for the treated topics. Typically, a thematic impulse or overview is given with a media-assisted presentation. Individual or group work assignments provide the possibility to apply the acquired competencies, to repeat and deepen these as well as to prepare the transfer to other fields.

Media:
Digital projector, board, flipchart, online contents, case studies

Reading List:
Recommended reading:
- Theodore (2017): Environmental management, Chapman and Hall/CRC.
- Antweiler (2014): Elements of environmental management, Univ. of Toronto Press.
- Belchem (2014): Manual of Environmental Management, Taylor and Francis.
- Amilleri (2017): Corporate sustainability, social responsibility and environmental management, Springer.
- Mitchell (2002): Resource and environmental management, Prentice Hall.
- Mulvihill and Harris (2017): Environmental management: critical thinking and emerging practices, Taylor and Francis.

Responsible for Module:
Röder, Hubert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Environmental Management (Exercise) (Übung, 2 SWS)
Röder H [L], Röder H

Environmental Management (Lecture) (Vorlesung, 2 SWS)
Röder H [L], Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0064BOK: BOKU: Biotechnology for Sustainable Processes and Environmental Protection | BOKU: Biotechnology for Sustainable Processes and Environmental Protection

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4	**Total Hours:** 100	**Self-study Hours:** 74	**Contact Hours:** 26

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

Description of Examination Method:
Written exam

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
Sustainable processes based on biotechnology
Biotechnology for valorization of biomass and energy production
Enzymatic degradation and processing of lignocellulose
Enzymatic functionalization of natural and synthetic polymers
Mechanisms of enzyme catalyzed degradation of xenobiotics
Enzyme catalysed reactions in soil and water
Enzyme-remediation
Biomarkers
Biotechnological processes with photo-autotrophic microorganisms

Intended Learning Outcomes:
Knowledge about biotechnology based strategies in sustainable processes.
Understanding of the basic principles in enzyme based degradation of xenobiotics and biomass degradation in nature.
Facts about biotechnology for valorization of biomass and about bioenergy production.

Students will be familiar with general principles of biotechnological processes with photo-autotrophic microorganisms and will understand typical advantages and disadvantages.

Teaching and Learning Methods:
Classroom lecture, self-study

Media:

Reading List:

Responsible for Module:
Georg Gübitz (BOKU)

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

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

Module Description

CS0065: Fundamentals of Thermodynamics | Grundlagen Thermodynamik

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 exam performance is effected by a written test. The students solve thermodynamical arithmetic problems and answer questions regarding the definitions and relations of thermodynamics. The students prove that they have understood the basic principles of thermodynamics by setting up and solving equations. Non-programmable calculators and a handed-out formulary are allowed aids. Exam duration: 90 minutes.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Mathematics

Content:
State variables, thermodynamic system, 1st and 2nd law, equations of state for ideal gases and fluid of constant density, process cycles, efficiencies, phase diagrams of pure substances

Intended Learning Outcomes:
After sucessful completion of the module the students know the 1st and 2nd law of thermodynamics; the are able to use thermal and caloric equations of state for ideal substance classes; they unterstand thermodynamic phenomena of phase change and related diagrams; they can apply the ideal gas law and the 1st and 2nd law to technical problems.

Teaching and Learning Methods:
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the

module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Presentations, slide scripts, exercises

Reading List:
P. STEPHAN, K. SCHABER, K. STEPHAN, F. MAYINGER: Thermodynamik, Band 1 Einstoffsysteme
16. Auflage, Springer, Berlin (2006); H.D. BAEHR, S. KABELAC: Thermodynamik, 13. Auflage, Springer, Berlin (2006)

Responsible for Module:
Jakob Burger burger@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

CS0065BOK: Technical Geometry and Computer-Aided Drawing (CAD) | Technische Geometrie und Computergestütztes Zeichnen (CAD)

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
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:

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

Module Description

CS0066: Introduction to Process Engineering | Einführung Verfahrenstechnik

Version of module description: Gültig ab summerterm 2019

Module Level: Bachelor	**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 exam performance is effected by a written test. Through comprehension questions it is reviewed whether the students have understood the basic priciples of process engineering. The students solve balance arithmetic problems and answer questions regarding the definitions and relations of material and energy balances. The students prove that they have understood the basics of conceptual process design by selecting suitable process units for a given separation task and by drawing of the process flowsheet. Non-programmable calculators and a handed-out formulary are allowed aids. Exam duration: 90 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Mathematics

Content:
Most important unit-operations: reactors, distillation, extraction, crystallization, absorption, membranes, filtration, evaporatoin. Material und energy balances of single units and whole processes. Conceptual process design.

Intended Learning Outcomes:
After sucessful completion of the module the students know the most important separation technologies of process engineering; they are able to balance them with respect to material and energy; they unterstand basics of reaction engineering; they can safely select unit operations and describe their mode of operation.

Teaching and Learning Methods:
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Presentations, slide scripts, exercises

Reading List:
Worthof & Siemes: Grundbegriffe der Verfahrenstechnik: Mit Aufgaben und Lösungen, 2012.
Schwister & Leven: Verfahrenstechnik für Ingenieure: Ein Lehr- und Übungsbuch, 2014.

Responsible for Module:
Jakob Burger burger@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

CS0066: Introduction to Process Engineering | Introduction to Process Engineering

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor	**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 exam performance is effected by a written test. Through comprehension questions it is reviewed whether the students have understood the basic priciples of process engineering. The students solve balance arithmetic problems and answer questions regarding the definitions and relations of material and energy balances. The students prove that they have understood the basics of conceptual process design by selecting suitable process units for a given separation task and by drawing of the process flowsheet. Non-programmable calculators and a handed-out formulary are allowed aids. Exam duration: 90 minutes.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Mathematics

Content:
Most important unit-operations: reactors, distillation, extraction, crystallization, absorption, membranes, filtration, evaporatoin. Material und energy balances of single units and whole processes. Conceptual process design.

Intended Learning Outcomes:
After sucessful completion of the module the students know the most important separation technologies of process engineering; the are able to balance them with respect to material and energy; they unterstand basics of reaction engineering; they can safely select unit operations and decribe their mode of operation.

Teaching and Learning Methods:
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Presentations, slide scripts, exercises

Reading List:
1. Basic Principles and Calculations in Chemical Engineering, 8th Edition, (David M. Himmelblau, James B. Riggs), Prentice-Hall Inc., New Jersey, 2012.
2. Introduction to Chemical Engineering: Tools for Today and Tomorrow, 5th Edition, (Kenneth A. Solen, John N. Harb), Wiley & Sons Inc., New Jersey, 2010.
3. Elementary Principles of Chemical Processes, 3rd Edition, (Richard M. Felder, Ronald W. Rousseau), Wiley & Sons Inc., New Jersey, 2004.
4. Perry's Chemical Engineers' Handbook, 9th Edition, (Don Green, Marylee Z. Southard), McGraw-Hill Education Ltd., New York, 2018.
5. Chemical Reaction Engineering, 3rd Edition, (Octave Levenspiel), Wiley India Pvt. Ltd., New Delhi, 2017.
6. Thermal Separation Technology: Principles, Methods, Process Design, 1st Edition, (Alfons Mersmann, Matthias Kind, Johann Stichlmair), Springer-Verlag Berlin Heidelberg GmbH, Berlin, 2011.

Responsible for Module:
Burger, Jakob; Prof. Dr.-Ing.

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

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

Module Description

CS0066BOK: Digital Image Processing | Digital Image Processing

Version of module description: Gültig ab summerterm 2023

Module Level:	**Language:** English	**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

CS0067: Macroeconomics | Macroeconomics [Macro I]

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**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 exam will be a written test (120 min.) at the end of the term. The exam is designed to assess the participants' capabilities to apply macroeconomic theory in order to discuss and solve real world problems of the economy as a whole. Participants should demonstrate their capacity for abstraction (thinking in economic models), concretization (calculating, interpreting and applying the results of the model, mathematical processing as well as graphical illustration.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
This module provides an introduction to basic concepts of macroeconomics. It covers:
- key institutions of capitalism as an economic system (private property, firms, markets)
- technological change as a trigger for economic growth
- price-taking and competitive markets
- price-setting, rent-seeking and market disequilibuium
- market successes and failures
- markets, contracts and information
- credit, banks and money
- economic fluctuations and unemployment
- unemployment, inflation, fiscal and monetary policy
- technological progress and living standards
- the Great Depression, the golden age of capitalism and the global financial crisis

Intended Learning Outcomes:
After attending the module, students will able to describe the composition and distribution of the Gross Domestic Product. They can analyze the economic mechanisms underlying unemployment as well as issues regarding monetary policy and inflation. Further, participants will learn to understand the economic crisis and the wealth differences among nations. Students are enabled to think in models and apply mathematical solutions when approaching economic problems.

Teaching and Learning Methods:
The module consists of a lecture and an exercise course. The lecture content will be delivered in a verbal presentation with the help of slides. Since the foundation of the lecture is a textbook including recent economic history, the teaching is full of real life examples. The content of the lecture is put into practice in the exercise course which applies the theoretical knowledge by basic mathematical calculations and graphical illustrations. Therefore, the module aims at encouraging participants to independently think about economic problems discussed in the lecture and in the current literature. Students are enabled to use the instruments (abstract and model thinking) for operationalizing economic problems and solve them in the conventional, mathematical manner.

This module is also offered at TUM Campus Straubing.

Media:
http://www.core-econ.org/

Reading List:
The CORE Project (2016): 'The Economy', in: Azm Premji University, Friends Provident Foundation, HM Treasury, Institute for New Economic Thinking, Open Society Foundations, SciencesPo, UCL (eds.), University College London.

Responsible for Module:
Pondorfer, Andreas; Prof. Dr.sc.pol.

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

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

Module Description

CS0067BOK: An Introduction Into Scientific Working | An Introduction Into Scientific Working

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 2	**Total Hours:** 60	**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

CS0068: Intermediate Microeconomics | Intermediate Microeconomics [Micro II]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
In the exam (written, 120 minutes) students should demonstrate their ability to adequately interpret advanced microeconomic concepts and apply the methods worked on in class. By means of multiple-choice-questions, which are either embedded in a context/case/scenario or require prior computation, students' capacity to apply the learned solution strategies to new settings and draw correct economic implications is assessed. They show their ability to assess and evaluate decisions under uncertainty and asymmetric information as well as strategic interaction of decision makers. Hereby, students demonstrate their capacity for abstraction (thinking in economic models) and concretization (interpreting and applying the results of the model). A non-programmable calculator is allowed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Microeconomics

Content:
The module imparts advanced concepts and methods of microeconomics, focussing on choice under uncertainty and strategic interaction. It examines markets under asymmetric information and imperfect competition.

Covered topics include Expected Utility Theory, Adverse Selection, Moral Hazard, Game Theory, and Strategic Interaction in Oligopolistic Markets.

These topics will be linked to current issues of climate policy and sustainability.

Intended Learning Outcomes:
After attending this module participants will be able to describe and evaluate decisions under uncertainty and/or asymmetric information. They will be capable of analyzing the functioning of competitive markets and assessing market failure arising from asymmetric information. They understand incentives and can solve problems of incentive compatibility. They know the fundamentals of game theory and are capable of analyzing strategic interaction like social dilemmas and coordination problems. Based on economic theory students can provide policy advice und evaluate concrete policy measures.

Teaching and Learning Methods:
An interactive lecture introduces advanced microeconomic concepts and theories and illustrates them with the help of topical empirical examples. Classroom experiments complement the classic bird-eye's perspective by nudging students to put themselves in the positition of particular economic players, thereby requiring them to actively reflect the concepts introduced. Online surveys at the end of each chapter enable students to select which topics they would like to intensify in subsequent classes. In the accompaying exercise class, students practice, on specific problems and examples, the mathematical techniques needed to develop a deeper understanding of the economic concepts. In self-study students use the textbook to repeat the concepts introduced in class and apply them to additional examples.

Media:
Text books, script, exercises, online polls, videos

Reading List:
- Gravelle, Hugh und Ray Rees (2004): Microeconomics, Pearson
- Jehle, Geoffrey und Philip Reny (2011): Advanced Microeconomic Theory, Pearson
- Kreps, David (1990): A Course in Microeconomic Theory, Princeton University Press
- Osborne, Martin (2004): An Introduction to Game Theory, Oxford University Press
- Shy, Oz (1996): Industrial Organization: Theory and Applications, MIT Press

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Intermediate Microeconomics (Lecture) (Vorlesung, 2 SWS)
Goerg S [L], Drobner C

Intermediate Microeconomics (Exercise) (Vorlesung, 2 SWS)
Goerg S [L], Drobner C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0068BOK: Citizen Science Seminar | Citizen Science Seminar

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:
1. Anwesenheitsp#icht bei mindestens drei Vorträgen 2. Seminararbeit über eines der Vortragsthemen, welches frei wählbar ist (es wird erwartet, dass Studierende weitere Literatur zum Thema recherchieren). Umfang der Seminararbeit: 8-12 Seiten Die Seminararbeit soll tiefergehende Informationen über das Vortragsthema enthalten und sich kritisch damit auseinandersetzen. Details dazu werden beim ersten Abhaltungstermin bekanntgegeben. 3. Die Zeugnisnote ergibt sich aus der Qualität der Seminararbeit .

Repeat Examination:

(Recommended) Prerequisites:

Content:
Citizen Science wird in den unterschiedlichsten Disziplinen immer öfter eingesetzt. Gut bekannt sind viele ökologische Projekte, in denen die Citizen Scientists Daten über das Vorkommen oder die
Verbreitung von Organismen sammeln, aber auch in den Geistes- und Sozialwissenschaften setzen
Wissenschaftler*innen immer öfter auf Citizen Science. In diesem Seminar möchten wir Gastvortragenden die Möglichkeit geben, aktuelle Projekte vorzustellen und mit Studierenden und anderen interessierten Personen zu diskutieren. Diese Vorträge werden viermal im Semester statt#nden und primär Projekte aus dem deutschsprachigen Raum abdecken.
Die Studierenden bekommen dabei einen Einblick in aktuelle Forschung und Projekte im Bereich Citizen Science und lernen dabei nicht nur wie ein Projekt funktionieren kann, sondern auch welche
Fallstricke es gibt. Am Ende des Semester wird von den Studierenden eine Seminararbeit über

eines der vorgestellten Projekte abgegeben, welche sich vertiefend mit dem vorgestellten Projekt befasst.

Intended Learning Outcomes:
Grundlagen wissenschaftliches Arbeiten
Ziel
1. Kennenlernen der Methode Citizen Science und diverser Projekte
2. Verbessertes Verständnis für Besonderheiten in der Zusammenarbeit mit Personen außerhalb der Wissenschaft
3. Kritisches Hinterfragen von wissenschaftlichen Methoden bzw. Ergebnissen

Teaching and Learning Methods:
Vorträge mit anschließender Diskussion, Recherche zu einzelnen Projekten, Verfassen einer Seminararbeit

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Zoologie

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

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

Module Description

CS0069: Business 1 - Controlling and Supply Chain | BWL 1 - Controlling and Supply Chain [BWL 1]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 of the module consists of an exam (written, 120 minutes). Allowed aid is a non-programmable calculator.

In the exam students show that they can apply different approaches to problem solving - based on the understanding of controlling as well as production and logistics planning in general. By means of exemplary objects from controlling and production or logistics planning the students demonstrate that they can interpret planning problems and connections between different problems and that they are able to interprete their results and apply the learnt instruments.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
This module is an introductory module for business administration. The module introduces students to the basics and instruments of Controlling (focus on business administration and sustainability) and Supply Chain Management (focus on production and logistics). It covers the following
topics:

(1) Introduction into controlling
(a) Description of controlling functions, tools of operative and strategic controlling
(b) Identification and application of key performance indicators
(c) Planning and monitoring: Operative, tactical and strategic planning and monitoring

(d) Case examples especially in business adminstration, environmental management and corporate social responsibility (CSR)

(2) Introduction to Production and Logistics
(a) Explaining strategic planning problems (e.g., site location planning), tactical planning problems (e.g., infrastructure of production systems), and operational planning decisions (e.g., demand forecasting techniques)
(b) Introduction into the material requirements planning and production planning
(c) Approaches to transport logistics, material logistics, the design of the logistics network, and methods used at the procurement and distribution stage.

Intended Learning Outcomes:
After participating in this introductory module, students will be able to:
(1) to remember and understand the basic concepts, tasks and conception of controlling systems and coordination systems.
(2) to analyze problems concerning the coordination of planning and control in management systems.
(3) to apply the newly acquired knowledge to solve these problems.
(4) understand the relation between different planning problems in production and logistics.
(5) analyse specific planning problems of the strategic, tactical and operational level, as well as on how to apply respective solution approaches.
(6) explain essential managerial tasks in production and logistics planning.
(7) evaluate the economic impact of production and logistics related decisions.

Teaching and Learning Methods:
The module consists of two lectures, two exercises and voluntary tutorials. During the lectures the contents are delivered by presentations and
discussions. The lectures are used to convey the theorectical foundations and include conducting some exercises. The students are inspired to improve the acquired knowledge by studying the suggested literature. In the exercises and tutorials students apply the acquired knowledge in solving exercises and implementing case studies. Students deepen their understanding through working in small student groups as well as solving exercises on their own.

Media:
Presentations, text books, lecture notes, exercises, lecture notes

Reading List:
- Einführung in das Controlling, Weber/Schäffer, Schäffer-Poeschel, 13. Auflage;
- Günther, H.O., Tempelmeier, H. (2016), Produktion und Logistik, 9. Auflage, Springer
- Ghiani, G., Laporte, G., Musmanno R. (2013), Introduction to Logistics Systems Management, 2. Aufl., Wiley
Controlling, Horvàth, Vahlen Verlag, 13. Auflage;
- Globales Life Cycle Controlling, Stibbe, Springer Gabler Verlag, 1. Auflage;

- Corporate Social Responibility und wirtschaftliches Handeln, Bruton, Erich Schmidt Verlag, 1. Auflage

Responsible for Module:
Hubert Röder hubert.roeder@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

CS0069BOK: Development Research and Practice | Development Research and Practice

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Continuous > attendance of 80% is compulsory > we will have short readiness tests at the beginning of each session. No #nal exam!

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge of English. The course is facilitated in a way that everyone can participate fully.

Content:
##Please note: we will not have a #nal exam, but short tests at the beginning of each session.
Participation in 80% of sessions is compulsory.##
Together with you, we want to address three questions:
Why development cooperation?
Our joint responsibility for global justice and sustainability based on the United Nations Sustainable Development Goals (SDGs)
What are the approaches in development cooperation?
Speci#c approaches and goals
transformative and human rights-based approaches
• Examples of goals in development cooperation: food and nutrition security, human right to adequate food, sustainable food systems, resilience, empowerment and women's rights, sustainable livelihoods, biodiversity
• The Sustainable Development Goals in international development
How is development cooperation done in practice?
Case studies from our work
• Sustainable #sheries

• Animal husbandry and resource con#icts in marginalised areas
• Large-scale land investment and land grabbing: impact on food and nutrition security
• Agroecology and organic farming
• Political cooperation and coherence

Intended Learning Outcomes:

Teaching and Learning Methods:
Vorlesung mit integrierten Übungen
Interactive learning with a focus on having a fruitful, rewarding time!

Media:

Reading List:

Responsible for Module:
BOKU- Institut für Entwicklungsforschung

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

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

Module Description

CS0070: Business 2 - Accounting and Entrepreneurship | BWL 2 - Accounting and Entrepreneurship [BWL 2]

Version of module description: Gültig ab summerterm 2019

Module Level: Bachelor	**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 examination consists of a 120-minute written exam.
Students answer theoretical questions and practical exercises about Accounting and Enrepreneurship. The written form of the exam allows a comprehensive assessment of students' knowledge and understanding of the basic principles. Students need to show that they are able to transfer the newly acquired knowledge to new contexts and to find solutions to subject-specific problems.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
This module is an introductory module for business administration. The module introduces students to the basics Accounting and the topic of Entrepreneurship. It covers the following topics:

(1) Introduction into Accounting introduces students to the basics of financial accounting. The following topics are covered:
(a) What are the main purposes for preparing an annual financial statement?
(b) Who are the addressees of the annual financial statement?
(c) What kind of information is available in the annual report and how does it help internal and external stakeholders in their decision-making?

(2) Introduction to Enteprenurship to introduce students into basic principles of the topic of entrepreneurship from a global and international perspective. Students will be equiped with basic knowledge on:
(a) Definitions, regional aspects, and special forms of entrepreneurship
(b) Entrepreneurial individuals, including their personality, creativity, idea development, cognition, opportunity recognition, decision making, affect, and moving forward from failure
(c) Entrepreneurial firms, including their growth strategies, strategic alliances, and resources.
(d) Students will engage in break-out group workshops to personally experience the process of opportunity recognition and development.

Intended Learning Outcomes:
After participating in this introductory module, students will be able to:
(1) demonstrate basic knowledge of financial accounting
(2) deal with voting rights and discretionary decisions in accounting.
(3) prepare annual financial statements and understand external audits
(4) evaluate the asset, financial and profit situation of firms, including the consequences of accounting policy decisions.
(5) explain basic concepts of entrepreneurship including basic definitions, psychological processes and characteristics of the person of the entrepreneur
(6) identify and explain potential development paths of young firms
(7) transfer basic knowledge to real world cases. Thus, students will be able to solve entrepreneurial problems in real world settings drawing on theoretical frameworks of the entrepreneurial process.

Teaching and Learning Methods:
The module consists of two lectures. The lectures several learning methods will be combined. The basic knowledge as well as real world examples will be provided through the lecture. Discussions in the lecture and active participation are encouraged and will contribute to deepen the understanding of the concepts introduced. Workshops in smaller groups enable the students to apply (part of) their theoretical knowledge to real-world problems. This format additionally fosters creativity and team work.
Students will get additional background knowledge from the scientific literature in private reading.

Media:
PowerPoint, films, internet, newspaper articles

Reading List:
- Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2010). Entrepreneurship (8th ed.). New York: McGraw-Hill.
- Read, S., Sarasvathy, S., Dew, N., Wiltbank, R. & Ohlsson, A.-V. (2010). Effectual Entrepreneurship. New York: Routledge Chapman &Hall.

Responsible for Module:
Claudia Doblinger

Courses (Type of course, Weekly hours per semester), Instructor:
Financial Accounting (Vorlesung, 2 SWS)
David G

Introduction to Entrepreneurship (Vorlesung, 2 SWS)
Doblinger C [L], Doblinger C, Fischer D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0070BOK: Energieholzbereitstellungssysteme | Energieholzbereitstellungssysteme

Version of module description: Gültig ab summerterm 2023

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

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:
BOKU

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

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

Module Description

CS0071: Basics of Material Flow Analysis and Life Cycle Assessment | Basics of Material Flow Analysis and Life Cycle Assessment [MFA&LCA]

Version of module description: Gültig ab summerterm 2019

Module Level: Bachelor	**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:
Written exam (90 minutes): Students have to solve problems from the thematic field of the module. They have to prove their ability to use the right vocabulary, apply their knowledge on life cycle and systems thinking, Material Flow Analysis and Life Cycle Assessment and in particular methods for the analysis and modelling of material and energy flows, data determination, uncertainty treatment and assessment of environmental impacts. Learning aids: pocket calculator.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The module contains units covering the following topics:
- Systems and life cycle thinking
- Material flow networks
- Material and energy flow balancing
- Material flow modelling
- Life Cycle Assessment
- Data determination
- Handling of data uncertainty
- Current trends and developments
- Software systems and data bases for material flow analysis and life cycle assessment
- Case studies

Intended Learning Outcomes:
The students use the concepts and tools of material flow analysis and life cycle assessment to analyse industrial metabolisms as well as products and services regarding their environmental impacts. Thus, they are able to gain a deeper understanding of their underlying material and energy flows and how they impact the environment. With these competencies development and improvement of systems, products and services can be supported, decision support delivered and communication with stakeholders aided.

Teaching and Learning Methods:
Format: lecture and (computer-based) exercises to introduce the content, to repeat and deepen the understanding as well as practice individually and in groups.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individual assignments and presentation
- Computer lab exercises using MFA and LCA software systems

Media:
Digital projector, board, flipchart, online contents, case studies, computer lab

Reading List:
Recommended reading:
- Baccini, P. & Brunner, P.H. (2012): Metabolism of the Anthroposphere: Analysis, Evaluation, Design. MIT Press.
- Brunner, P.H. & Rechberger, H. (2003): Material Flow Analysis. CRC Press.
- Curran, M.A. (2015): Life Cycle Assessment Student Handbook, Scrivener Publishing:
- Guinée, J.B. (2002): Handbook on life cycle assessment: operational guide to the ISO standards. Kluwer, Dordrecht.
- Hauschild, M.Z. & Huijbregts, M.A.J. (2015): Life Cycle Impact Assessment (LCA Compendium - The Complete World of Life Cycle Assessment), Springer.
- Klöpffer, W. & Grahl, B. (2014): Life Cycle Assessment (LCA), Wiley-VCH.

Responsible for Module:
Magnus Fröhling magnus.froehling@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

CS0071: Material Flow Analysis and Life Cycle Assessment | Material Flow Analysis and Life Cycle Assessment [MFA&LCA]

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**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:
Large courses of approx. more than 60 students: Written exam (90 minutes):
Students have to solve basic problems from the MFA, and LCA field. They have to demonstrate that they can analyze systems from a system and life cycle perspective. They have to prove their ability to use the correct terminology. In particular, they need to prove their ability to analyze and model material and energy flows, to determine and apply data, to assess environmental impacts, and to consider uncertainties. In addition they have to demonstrate their ability to interpret MFA and LCA study results and discuss the importance and applicability of the methods in practice.
Learning aids: pocket calculator.

Small to medium sized courses with up to approx. 60 students:
The students demonstrate the above-mentioned capabilities through group work. In groups of 3-5 students they receive case-based problems of material flow analysis and/or life cycle assessment. They have to solve these using the competencies obtained in the course. The results have to be presented and discussed (ca. 20') as well as documented in a report (ca. 20 pages). The individual contributions in both, presentation and report have to be specified.

The form of examination will be announced in class and on the learning platform in the second lecture week of the semester at the latest.

Voluntarily, students have the opportunity to increase their grade by up to 0.3 through extra work in form of individual assignments (hand-in and or presentation). The students either have to discuss a case study or a scientific paper or solve a problem from the topical scope of the lecture. They have to summarize their results in a 10' presentation + discussion or a 2-3 page report. Full mark for the course is obtainable without this voluntary work.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
• Introduction to systems and life cycle thinking
• The four phases of life cycle assessment
o Goal and scope definition
o Life cycle inventory analysis (LCI)
o Life cycle impact assessment (LCIA)
o Interpretation
• Material flow analysis
o Method of material flow analysis
o Material flow networks
o Determination of mass flows and stocks
o Material flow modelling
• Software systems and databases for material flow analysis and life cycle assessment
• Uncertainties and their handling
• Current trends and developments in material flow analysis and life cycle assessment
• Case studies

Intended Learning Outcomes:
At the end of the module students
• define key terms of material flow analysis and life cycle assessment
• explain the concepts of material flow analysis, life cycle assessment and systems analysis regarding their procedures and their theoretical backgrounds
to understand how to apply material flow analysis and life cycle perspective to various contexts and systems in order to assess their environmental performance
• gather necessary information, to choose suitable methods, and to apply these for simple MFA and LCA studies
• carry out simple MFA and LCA calculations by investigating underlying resource and energy flows associated with processes
• interpret MFA and LCA study results
• discuss the importance and applicability of the methods in practice

Teaching and Learning Methods:
Format: lecture and exercises to introduce the content, to repeat and deepen the understanding as well as practice individually and in groups. Some tutorials will be carried out computer-based.

Teaching / learning methods:
• Media-assisted presentations
• Group work/case studies

• Individual tasks
• Reading
• Computer lab exercises using MFA and LCA software systems

Media:
Digital projector, board, flipchart, online contents, videos, case studies, computer lab

Reading List:
• Baccini, P. & Brunner, P.H. (2012): Metabolism of the Anthroposphere: Analysis, Evaluation, Design. MIT Press.
• Brunner, P.H. & Rechberger, H. (2016): Handbook of Material Flow Analysis: For Environmental, Resource, and Waste Engineers. CRC Press.
• Curran, M.A. (2015): Life Cycle Assessment Student Handbook, Scrivener Publishing.
• Fröhling, M.; Hiete, M. (2020): Sustainability and Life Cycle Assessment in Industrial Biotechnology. Springer, Cham.
• Guinée, J.B. (2002): Handbook on life cycle assessment: operational guide to the ISO standards. Kluwer, Dordrecht.
• Hauschild, M.Z. & Huijbregts, M.A.J. (2015): Life Cycle Impact Assessment (LCA Compendium - The Complete World of Life Cycle Assessment), Springer, Cham.
• Hauschild, M.; Rosenbaum, R.K.; Olsen, S.I. (2018): Life Cycle Assessment: Theory and Practice. Springer, Cham.
• Jolliet, O., Saade-Sbeih, M. (2015): Environmental Life Cycle Assessment. CRC Press.
• Klöpffer, W. & Grahl, B. (2014): Life Cycle Assessment (LCA), Wiley-VCH.

Responsible for Module:
Fröhling, Magnus; Prof. Dr. rer. pol.

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

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

Module Description

CS0071BOK: Environmental Bioprocess Engineering | Environmental Bioprocess Engineering

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 30	**Contact Hours:** 90

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

Description of Examination Method:
Students have 60 min to answer 6 questions. Grading is based on correct answers as follows: 5: less than 50% 4: 50-70% 3: 71-80% 2: 81-90% 1: 91-100%

Repeat Examination:

(Recommended) Prerequisites:
Grundkenntnisse in Chemie, Biochemie, Mikrobiologie und Verfahrenstechnik

Content:
This lecture on bioprocess engineering focuses on processes that are of key importance for environmental biotechnology. Beside a pure civil engineering part, emphasis is put on biological requirements of environmental methods and techniques. Results of practical experiments and full scale applications will be discussed.
The following topics will be covered:
- Contaminated Land Management
- Microbial Conversion and Storage of Renewable Energy
- Principles and Application of Anaerobic Digestion
- Biotechnological Valorisation of Organic Wastes and Residues

Intended Learning Outcomes:
Students will gain fundamental knowledge in environmental biotechnology and associated processes. They will be able to describe and explain techniques like biogas and composting plants.
In addition, calculations for dimensioning of soil remediation facilities and for quantifying remediation success will be accomplished.

Students will understand the concept of sustainability and be able to #nding solutions for environmental issues.

Teaching and Learning Methods:
Interaktion Lehrende und Lernende

Media:

Reading List:

Responsible for Module:
BOKU - Department für Agrarbiotechnologie

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

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

Module Description

CS0072: Policy and Innovation | Policy and Innovation

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 grading is based on a written exam (90 Minutes). The written form of the exam allows a comprehensive assessment of students' knowledge and understanding of the basic principles of policy and innovation. They will answer questions about the concepts explaining the strategies and options that policymakers and firms have in order to promote the usage of renewable resources. They will also answer questions about policy effects on the innovation activities of different actors and evaluate the implications for technology development and diffusion.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Entrepreneurship, Introduction to Innovation Management

Content:
The module introduces students into basic principles of the topic of policy and innovation from a global and international perspective. Students will be equiped with basic knowledge on:
- definitions about policy and innovation
- assessment of politcal incentives, especially related to climate change and renewable resources
- relation to sustainability, networks, ecosystems and social innovation.

Beyond that, students will engage in break-out group workshops to personally experience the process of developing business models in the context of climate change / renewable resources. Students give presentations to the audience and discuss their results.

Intended Learning Outcomes:
Following the completion of the course, the students will be familiarized with theoretical concepts and empirical methods to:

- assess policy effects on the innovation activities of different actors and evaluate the implications for technology development and diffusion
- identify and evaluate business opportunities and design business concepts/plans in the context of renewable resources / climate change
- understand institutional and technological barriers that affect large-scale system transformations and be able to develop scenarios for policy and firms to meet environmental and societal goals

Teaching and Learning Methods:
The module will combine several learning methods.
- The basic knowledge as well as real world examples and case studies will be provided through the lecture.
- Discussions in the lecture and active participation are encouraged and will contribute to deepen the understanding of the concepts introduced.
- In the tutorial, the academic concepts will be discussed and applied in case studies. The students will further apply (part of) their theoretical knowledge to real-world problems and present their results in teams. This format fosters team work.
- Students will get additional background knowledge from the scientific literature in private reading.

Media:
Presentation, Power-Point Slides, Case Studies

Reading List:
Fagerberg, J.; Mowery, D.C.; Nelson, R.R. (eds.), 2005: The Oxford Handbook of Innovation. Oxford University Press, Oxford.

Responsible for Module:
Doblinger, Claudia; Prof. Dr. rer. pol. 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

CS0072BOK: Facilitating Change for Sustainable Development | Facilitating Change for Sustainable Development

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Individual assessment

Repeat Examination:

(Recommended) Prerequisites:
This course is the second out of three, o#ering students insights into the management of farm and food system transitions in complex environments of the global south. The other two courses are Livelihood system dynamics in rural development (934304) and Participatory methods in development research and practice (934317)

Content:
Change that brings about sustainable agriculture, fair food systems and human wellbeing has long been an important goal in international development. This course focuses on facilitating change within households, communities or food value chains. It conceptualizes change as the co-evolution
of complex adaptive systems, underpinned by a selection of change theories and process models. Facilitators - such as agricultural advisory service providers - can mix these theories and models to
help stakeholders to create change and impact pathways. Since all change is impermanent and context dependent – that is, dependent on interrelationships, interdependencies, interconnectedness – the course emphasizes the need for integration and for understanding the whole – for example the importance of:
- Broadening perspectives (multi-level, multi-stakeholders, across timescales) of all actors in agricultural development and related systems;
initiatives;

- Collaborative leadership and collaborative networks within and between farmer communities;
- Integrating internal as well as external factors (drivers) of change in sustainable development processes.

The course aims to acquaint future practitioners with the theoretical foundation for facilitating complex change processes in the #eld of agriculture and sustainable development

Intended Learning Outcomes:
1. Recall conventional development models and alternative approaches.
2. Identify good learning principles for facilitating a change process with adult groups.
3. Understand the importance of group dynamics for facilitation processes.
4. Apply facilitation methods in the role of a “change facilitator”.
5. Debate on the challenge of translating program goals into real interaction.
6. Propose means to overcome barriers towards a new professionalism in agricultural development.
7. Organise facilitation methods into method families.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Entwicklungsforschung

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

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

Module Description

CS0073: Circular Economy | Circular Economy [CEC]

Version of module description: Gültig ab summerterm 2019

Module Level: Bachelor	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:
Written exam (90 minutes): Students have to analyse and assess (simplified) circular economy concepts on a local, regional, national and global level and determination of starting points for an optimisation of these concepts with methods of material flow analysis, life cycle assessment and quantitative management approaches. In addition, they have to elaborate, assess and discuss business models in this field. In doing so, the students have to prove their ability to use the right vocabulary, and their knowledge on the motivation and key figures of circular economy.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The module contains units covering the following topics:
- Necessity and importance of closed material cycles
- Product and material life cycles, their prolongation and extension
- Thermodynamic principles and their consequences for a circular economy
- Local material cycles and industrial symbiosis
- Regional material cycles
- Global material cycles
- Circular economy concepts for renewable resources
- Circular economy concepts for non-renewable resources
- Emerging business models in a circular economy

Intended Learning Outcomes:
Student have a basics understanding of the concepts of circular economy. They discuss the aim of closing material loops on the global, national and regional level beyond the current situation, technological and organisational options, boundaries set by chemical and physical laws and regulatory frameworks. They are able to identify business opportunities, develop and discuss new innovative business models.

Teaching and Learning Methods:
Format: lecture and exercises to introduce the content, to repeat and deepen the understanding as well as practice individually and in groups.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individual assignments and presentation

Media:
Digital projector, board, flipchart, online contents, case studies

Reading List:
Recommended reading:
- Ayres, Robert U. (2002): A handbook of industrial ecology
- Baccini, Peter (1991): Metabolism of the Anthroposphere, Springer
- Baker-Brown, Duncan (2017): The re-use atlas a designer's guide towards a circular economy
- Charter, Martin (2019): Designing for the circular economy, Routeledge
- De Angelis, Roberta (2018): Business Models in the Circular Economy: Concepts, Examples and Theory, Palgrave Macmillan
- Franco-García, María-Laura ; Carpio-Aguilar, Jorge Carlos ; Bressers, Hans: Towards Zero Waste: Circular Eocnomy Boost, Waste to Resources, Springer
- Larsson, Mats (2018): Circular Business Models: Developing a Sustainable Future
- Schaub, Georg; Turek, Thomas (2016):
- Energy Flows, Material Cycles and Global Development: a Process Engineering Approach to the Earth System, Springer
- Webster, Ken (2017): The Circular Economy - A Wealth of Flows, Ellen MacArthur Foundation Publishing

Responsible for Module:
Magnus Fröhling magnus.froehling@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

CS0073: Circular Economy | Circular Economy [CEC]

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	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:
Examination for course sizes of more than approx. 70 students:
Written exam (90 minutes): Students have to analyze, assess and discuss (simplified) circular economy concepts and legislative frameworks on a local, regional, national and global level, determine starting points for an optimization of these concepts and apply them to real-life use cases. Thereby, they have to take different points of view (environmental, product, (material flow) system, macroeconomic, business). In doing so, the students have to prove their ability to use the right vocabulary, and their knowledge on the motivation, and methods of circular economy.

Examination for course sizes of up to approx. 70 students:
The students demonstrate the above-mentioned capabilities through group work. In groups of 3-5 students they receive case-based problems of the CE. They have to solve these using the competencies obtained in the course. The results have to be presented and discussed (ca. 20') and documented in a report (ca. 20 pages). The individual contributions in both, presentation and report have to be specified.

The form of examination will be announced in class and on the learning platform in the second lecture week of the semester at the latest.

Voluntarily, students have the opportunity to increase their grade by up to 0.3 through extra work in form of individual assignments (hand-in and or presentation). The students either have to discuss a case study or a scientific paper or solve a problem from the topical scope of the lecture. They have to summarize their results in a 10' presentation + discussion or a 2-3 page report. Full mark for the course is obatainable without this voluntary work.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The module covers the following topics:
• Introduction
• Circular Economy as a concept to approach sustainability needs
• History and policies related to the development of a circular economy
• Motivation for CE
• Design for Sustainability and Circularity
• Business model innovation for CE
• Closed-loop economic systems
• Sustainability Assessment of CE solutions
• Enablers and barriers, potentials and limits of CE
• Rebound effects
• Special topics and case studies

Intended Learning Outcomes:
Students explain the importance of the circular economy within the context of resource shortages, climate change and further sustainability challenges. They discuss and understand the central concepts of a circular economy against their historical background covering both, traditional waste management and recycling approaches as well as more recent holistic concepts. They asses and discuss CE from an environmental, product, material, and economic perspective. Based on these competences, they can develop action approaches to transfer these concepts from theory into practice. They link independently urgent environmental problems of our time with the concept of the circular economy and design solution approaches based on their results. Regarding value creation in a circular economy, the students identify business opportunities, develop and discuss new innovative business models. They apply these concepts to specific use cases, and assess their implications from different perspectives, considering potentials and limits, enablers and barriers.

Teaching and Learning Methods:
Format: lecture and exercises to introduce the content, to repeat and deepen the understanding as well as practice individually and in groups.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies / reading of scientific publications with presentation
- Individual assignments and presentation to consolidate/repeat the learned contents
- Dismantling and recycling exercises in the CE-lab
- Plenary discussions to reflect the lecture contents

Media:
Digital projector, board, flipchart, online contents, case studies, computer lab

Reading List:
Recommended reading:
• Ayres, Robert U. (2002): A handbook of industrial ecology
• Charter, Martin (2019): Designing for the circular economy, Routeledge
• De Angelis, Roberta (2018): Business Models in the Circular Economy: Concepts, Examples and Theory, Palgrave Macmillan
• Franco-García, María-Laura ; Carpio-Aguilar, Jorge Carlos ; Bressers, Hans: Towards Zero Waste: Circular Eocnomy Boost, Waste to Resources, Springer
• Larsson, Mats (2018): Circular Business Models: Developing a Sustainable Future
• Schaub, Georg; Turek, Thomas (2016): Energy Flows, Material Cycles and Global Development: a Process Engineering Approach to the Earth System, Springer
van Erwijk, S.; Stegemann, J. (2023): An Introduction to Waste Management and Circular Economy, UCL Press
• Webster, Ken (2017): The Circular Economy - A Wealth of Flows, Ellen MacArthur Foundation Publishing
• Wiesmeth, H. (2021): Implementing the Circular Economy for Sustainable Development, Elsevier
Further literature will be given in the course.

Responsible for Module:
Fröhling, Magnus; Prof. Dr. rer. pol.

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

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

Module Description

CS0073BOK: First Steps with R | First Steps with R

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:
continuous assessment of course work, homework

Repeat Examination:

(Recommended) Prerequisites:

Content:
This course covers the #rst steps with the statistical computing environment R. It is the basis of many other courses o#ered at the Institute of Statistics and will be held as a blocked course at the beginning of the semester.
R is a #exible and powerful statistics program that is freely available. R is a noncommercial alternative to programs like SAS, SPSS, or S-PLUS.
The following topics will be covered:
* Installation, packages
* R as calculator, data types, classes, random number generator, control structures
* RStudio as an editor: RStudio is an integrated development environment (IDE) for R and includes
a console, a syntax-highlighting editor that supports direct code execution, as well as tools for plotting, history, debugging and workspace management.
* R Markdown reports: R Markdown documents are fully reproducible and weave together narrative text and code to produce elegantly formatted output.

Intended Learning Outcomes:
Participants should be able to use the basic functions of the R programming system and to do elmentary statistical analyses

Teaching and Learning Methods:
Vorlesung mit integrierten Übungen

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Statistik

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

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

Module Description

CS0074BOK: Frontiers in Social Ecology and Sustainability Transformations | Frontiers in Social Ecology and Sustainability Transformations

Version of module description: Gültig ab summerterm 2023

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

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:
BOKU

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

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

Module Description

CS0075: Management Science | Management Science

Version of module description: Gültig ab summerterm 2019

Module Level: Bachelor	**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:
Students mastery of the content taught in this module is checked with a 60 minutes written exam. Students are only allowed to use a non-programmable calculator. In the exam students have to answer questions, apply algorithms to solve problems, create mathematical models for small example problems, and discuss presented results. By this the students have to demonstrate that they have understood and can apply the mathematical models and methods to solve business planning problems. The overall grade of the module is based on the result obtained in the written exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of Mathematics and Statistics at the level as definend in the German Abitur

Content:
Management Science is about modeling, solving and analyzing planning and decision problems using mathematial concepts. Management Science is used across different industries, departments and organizations. The lecture will treat the Management Science approach to decision making in general and the following topics in particular: Linear Programming, Mixed-Integer Programming, Graph Theory, Netwerk Flow, Dynamic Programming and Decision Theory.

Intended Learning Outcomes:
After successful completion of the module students are capable of modelling planning problems. They are able to solve small business problems manually by using models and methods of linear and horizontal programming, of graph theory, of network flow, of dynamic programming, and of decision theory.

Teaching and Learning Methods:
The module consists of a lecture and exercise courses, which are provided weekly, as well as a voluntary tutorial offered biweekly. In the lecture the content is jointly developed with the students mainly by using slides. The exercise course repeats parts of the lecture contents by using examples. The tutorials are delivered by student teaching assistants for groups of up to 20 students which gives the student the opportunity to pose questions and receive immediately help from the teaching assistant.

This module is also offered at TUM Campus Straubing.

Media:
Script, Presentation slides

Reading List:
- Bradley, S.P., A.C. Hax und T.L. Magnanti: Applied Mathematical Programming, Addison-Wesley, 1977. Domschke W and A. Drexl: Einführung in Operations Research, 9th Ed., Springer, 2015.
- Hillier FS and Lieberman GJ: Introduction to Operations Research, 9th ed., McGraw-Hill, 2010. Winston WL: Operations Research, 5th Ed., Thomson, 2004.
- Hillier FS and Lieberman GJ: Introduction to Operations Research, 9th ed., McGraw-Hill, 2010. Winston WL: Operations Research, 5th Ed., Thomson, 2004.

Responsible for Module:
Alexander Hübner alexander.huebner@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Management Science Exercise - Campus Straubing (Übung, 2 SWS)
Hübner A [L], Schäfer F

Management Science Lecture - Campus Straubing (Vorlesung, 2 SWS)
Hübner A [L], Schäfer F
For further information in this module, please click campus.tum.de or here.

Module Description

CS0075: Management Science | Management Science [ManSci]

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor	**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 mastery of the content taught in this module is checked with a 60 minutes written and multiple-choice exam. In the written part of the exam students have to answer questions, apply algorithms to solve problems, create mathematical models for small example problems, and discuss presented results. By this, the students have to demonstrate that they have understood and can apply the mathematical models and methods to solve business planning problems. The multiple-choice questions allow to check if students also understood other parts of the lecture that could not be included in the written part. This will be used to assess if fundamental aspects in Management Science can be evaluated. The overall grade of the module is based on the result obtained in the written and multiple-choice exam. Students are only allowed to use a non-programmable calculator.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge of Mathematics and Statistics at the level as definend in the German Abitur

Content:
Management Science is about modelling, solving and analysing planning and decision problems using mathematical concepts. Management Science is used across different industries, departments and organizations. The lecture will treat the Management Science approach to decision making in general and the following topics in particular: Linear Programming, Mixed-Integer Programming, Graph Theory, Network Flow, Dynamic Programming and Decision Theory.

Intended Learning Outcomes:
After successful completion of the module, students are capable of modelling planning problems. They are able to solve small business problems manually by using models and methods of linear

and integer programming, of graph theory, of network flow, of dynamic programming, and of decision theory.

Teaching and Learning Methods:
The module consists of a lecture and exercise courses, which are provided weekly, as well as a voluntary tutorial offered. In the lecture, the content is jointly developed with the students mainly by using slides. The exercise course repeats parts of the lecture contents by using examples. The tutorials are delivered by student teaching assistants for smaller groups which gives the student the opportunity to pose questions and receive immediately help from the teaching assistant.

Media:
Script, Presentation slides

Reading List:
Bradley, S.P., A.C. Hax und T.L. Magnanti: Applied Mathematical Programming, Addison-Wesley, 1977.
Domschke W and A. Drexl: Einführung in Operations Research, 9th Ed., Springer, 2015.
Hillier FS and Lieberman GJ: Introduction to Operations Research, 9th ed., McGraw-Hill, 2010.
Winston WL: Operations Research, 5th Ed., Thomson, 2004.

Responsible for Module:
Hübner, Alexander; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Management Science Exercise - Campus Straubing (Übung, 2 SWS)
Hübner A [L], Schäfer F

Management Science Lecture - Campus Straubing (Vorlesung, 2 SWS)
Hübner A [L], Schäfer F
For further information in this module, please click campus.tum.de or here.

Module Description

CS0075BOK: Geographic Information Systems (GIS) in Education for Sustainable Development | Geographic Information Systems (GIS) in Education for Sustainable Development

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 30	**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:
BOKU

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

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

Module Description

CS0076: Enzyme Engineering | Enzym Engineering

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer 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:
To prove that the students are able to show ways to optimize enzymes in their properties and to do this methodically, there is a written exam with a duration of 60 minutes and a written seminar report has to be prepared, the total grade of which is composed of the exam grade (67%) and the grade of the seminar report (33%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisite for successful participation is proof of knowledge of the fundamentals of enzymatics, molecular biology molecular biology, bioprocess engineering, and general basic chemistry knowledge.

Content:
The aim of the module is to teach molecular biology and protein chemistry approaches for the optimization of enzymes, especially by variation of the primary structure. Essential contents are: Limitation analysis at the molecular level, rational methods, computational methods, evolutionary and combined methods, high throughput methods, robotics. The goal of the seminar is to teach basic bioinformatics tools used in rational enzyme design, such as ligand docking, energy minimization, and rational introduction of mutations. These methods will be practiced on real enzymes and used to generate improved enzyme variants for a specific engineering target.

Intended Learning Outcomes:
After attending the lecture, students are able to identify options for improving technically limited enzymes, to estimate the effort required for this and have the theoretical ability to methodically implement these improvements in the subsequent practical course Enzyme Optimization. After

participation in the seminar, the students are able to use different bioinformatic tools for rational enzyme design and to evaluate the results of the generated informatic predictions.

Teaching and Learning Methods:
The lecture is conducted as an ex cathedra teaching in order to provide the students with all necessary basics. In addition, the students work out individual methods and procedures independently, e.g. on the basis of current scientific literature, and present these to each other in a presentation. In the seminar, students are guided through the individual steps of a rational enzyme technology approach with the help of a script. The results of these steps are summarized in a written report to place the individual steps in a larger context. On the one hand, a seminar in which students present current literature on topics covered in the lecture as well as apply and deepen in silico methods for rational enzyme design is designed to internalize and deepen the methods and approaches for optimizing enzymes presented in the lecture. On the other hand, in the seminar students work on concrete problems and questions on topics of rational enzyme design and train and deepen application-oriented work with the help of the presented software packages.

The slides of the lecture and the seminar presentations will be made available online after the respective event.

Media:
PowerPoint, Slide scripts, scientific literature
Lecture: PPT and board
Seminar: PPT, board and software- and online based methods on individual PCs or in a PC classroom

Reading List:
For introduction the following books are adviced:
“Directed Enzyme Evolution: Screening and Selection Methods” (Methods in Molecular Biology) und
“Directed Evolution Library Creation: Methods and Protocols” (Methods in Molecular Biology), beide
Frances H. Arnold, George Georgiou (Hrsg.), Springer, Berlin;
“Protein Engineering Protocols” (Methods in Molecular
Biology), Katja M. Arndt und Kristian M. Muller (Hrsg.), Springer, Berlin.

Responsible for Module:
Prof. Volker Sieber

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

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

Module Description

CS0076BOK: Geometry for Engineers and Computer Aided Design | Geometry for Engineers and Computer Aided Design

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 60	**Contact Hours:** 60

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:
BOKU

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

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

Module Description

CS0077: Fundamentals of Thermodynamics | Grundlagen Thermodynamik

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German	**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 module's graded examination reqirement consists of a written exam. The students solve thermodynamical arithmetic problems and answer questions regarding the definitions and relations of thermodynamics. The students prove that they have understood the basic principles of thermodynamics by setting up and solving equations. Non-programmable calculators and a handed-out formulary are allowed aids. Exam duration: 90 minutes.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Mathematics (MA9711 Mathematics in Natural and Economic Science 1)

Content:
State variables, thermodynamic system, 1st and 2nd law of thermodynamics, equations of state for ideal gases and fluids of constant density, process cycles, efficiencies, phase diagrams of pure substances

Intended Learning Outcomes:
Upon successful completion of the module, students know the 1st and 2nd law of thermodynamics. They are able to apply thermal and caloric equations of state for ideal substance classes. They understand thermodynamic phenomena of phase change and related diagrams. The students can apply the ideal gas law and the 1st and 2nd law to technical problems.

Teaching and Learning Methods:
The module consists of a lecture and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge, students shall be encouraged to study

the literature and reexamine the previous topics. In the exercises, skilled theory is directly applied to arithmetic examples as practical orientation.

Media:
Presentations, slide scripts, exercises, Moodle

Reading List:
P. STEPHAN, K. SCHABER, K. STEPHAN, F. MAYINGER: Thermodynamik, Band 1 Einstoffsysteme
16. Auflage, Springer, Berlin (2006); H.D. BAEHR, S. KABELAC: Thermodynamik, 13. Auflage, Springer, Berlin (2006)

Responsible for Module:
Prof. Jakob Burger

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

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

Module Description

CS0077BOK: Global Change and Pest Management | Global Change and Pest Management

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The exam will be taken in written form and lasts 120 min. 12 questions are to answer with a mean duration of 10 min. One question is related to the lecture of Herbert Formayer, four to Gernot Hoch and seven to Andreas Walzer. The assessment criteria (4 points per question, reachable points in total = 48) are the following: 44 points (92%) = 1; 38 points (79%) = 2; 34 points (71%) = 3;

Repeat Examination:

(Recommended) Prerequisites:
lecture units signi#cantly enables the probability to reach the learning outcomes.

Content:
In the lecture we will present the global change drivers land use change, biotic invasions and climate change, which have strong implications on pest management in agriculture and forestry. We introduce the dimensions and causes of each global change driver and discuss their e#ects on pests in agriculture (8 units) and forestry (4 units) on the basis of scienti#c case studies. The detailed topics are (1) land use change: green revolution, increased use of pesticides and N-fertilizer and their e#ects on pest species, the loss and fragmentation of natural habitats; (2) biotic invasions: neobiota as invasive pest and weeds – pathways, risk, approaches for control; (3) Climate change: basics, e#ects of increased atmospheric CO_2 concentrations and ambient temperatures on pest species, climate change scenarios; and (4) interaction e#ects between biotic invasions and climate change.

Intended Learning Outcomes:
The students acquire knowledge about the causes of global change and its interplay with pest

management in agriculture and forestry. In detail, students understand how land use changes can a#ect population dynamics of pest arthropods and particularly biological control by their natural enemies. Students will be aware of the challenges arising from neobiota becoming invasive pests. They know about possible pathways, risks and control approaches; they understand how climate change could impact pest management in agriculture and forestry. They know how changes in temperature, precipitation, and atmospheric CO2 can a#ect host plants, herbivorous arthropods and their natural enemies as well as the trophic interactions in the system. They realize the interactions of biotic invasions and climate change a#ecting pest management. Finally, they are able to describe and discuss the quintessence of scienti#c tables and #gures in publications dealing
with global change and pest management.

Teaching and Learning Methods:
Frontalvorlesung

Media:

Reading List:
PDFs of the slides are available on boku.learn

Responsible for Module:
BOKU - Institut für Pflanzenschutz

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

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

Module Description

CS0078: Advanced Seminar in Innovation and Technology Management | Advanced Seminar in Innovation and Technology Management

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**Contact Hours:** 60

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

Description of Examination Method:
The learning results are going to be proved in form of a written thesis. The students write a theoretical and/or empirical thesis of 15-20 pages depedning on the type of current research problem in the area of Innovation and Technology Management. They prove that they have understood the content of the current academic literature and are able to conduct empirical analyses.

Repeat Examination:

(Recommended) Prerequisites:
Innovation in Bioeconomy

Content:
Current research questions from the area of Innovation and Technology Management, e.g., Ecosystems, sustainable innovation, digitization.

Intended Learning Outcomes:
After successful completion of the module the students are able to derive an advanced academic research question and to respond to it by using the relevant literature in the area of innovation and technology management. The research questions are typically related to the promotion of sustainable innovation or entrepreneurship within ecosystems. In addition to the required literature analysis based on peer-reviewed academic journals, the students are able to conduct and interpret relevant empirical analyses.

Teaching and Learning Methods:
Teaching methods: The students will be familiarized with the basics to conduct literature reviews in the area of innovation and technology management and to conduct and interpret empirical analyses using statistical programs like STATA, R or Python. The students apply these contents to their own research questions in the thesis. The students present their results in front of the other seminar members, and discuss their results with the group.
The students have to write a seminar thesis in order to learn how to write an academic paper based on a relevant research question in the area of innovation and technology management.

Media:
Presentations, Power-Point Slides

Reading List:
Relevant research papers will be provided

Responsible for Module:
Claudia Doblinger claudia.doblinger@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar in Innovation and Technology Management (Seminar, 4 SWS)
Doblinger C [L], Doblinger C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0078BOK: Innovation Processes in the Forest-based Bioeconomy | Innovation Processes in the Forest-based Bioeconomy

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

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

Description of Examination Method:
Prüfungsimmanent (Diskusion der zu lesenden Texte und abschließende Präsentation der eigenen Reflexion)

Repeat Examination:

(Recommended) Prerequisites:
Kenntnis der Methoden wissenschaftlichen Arbeitens wird ausdrücklich empfohlen

Content:
Die LVA setzt den Fokus auf Innovations- und Bioökonomieforschung im Kontext der Forst- und Holzwirtschaft, und erweitert diese um systemische Perspektiven hinsichtlich technologischer Innovationen, geeigneter sozioökonomischer und ökosozialer Rahmenbedingungen.

Intended Learning Outcomes:
• Einführung in den wissenschaftlichen Diskurs zu den Themen Bioökonomie, Circular Economy, und Sustainable Development im Kontext von Innovationsprozessen in der Forst- und Holzwirtschaft.
• Einblick in folgende Forschungsfelder als interdisziplinärer Zugang zur Betrachtung der Wertschöpfungskette Holz in Innovationsprozesse
Umweltbewertung im Innovationsprozess
- Gesellschaftliche Wahrnehmung hinsichtlich Ressourcennutzung, Produktionsprozessen und Produkten
• Studierende lernen aktuelle Diskurse als Forschungskontext und als Rahmenbedingungen für Innovationsprozesse kennen.
• Studierende erwerben die Kompetenz, Problemstellungen in der (holzbasierten) Bioökonomie zu

re#ektieren und einen Forschungsbedarf abzuleiten.
• Studierende der Lehrveranstaltung werden befähigt mit wiss. Quellen fundiert zu diskutieren, ihre Argumente zu strukturieren und Forschungsfragen zu Innovationsprozessen in der holzbasierten Bioökonomie zu formulieren.

Teaching and Learning Methods:
Impusvorträge der Lehrenden, Guided reading und gemeinsame Reflexion

Media:

Reading List:
Wird auf BokuLearn (https://learn.boku.ac.at/) zur Verfügung gestellt

Responsible for Module:
BOKU - Institut für Marketing und Innovation

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

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

Module Description

CS0079: Resource and Energy Management | Resource and Energy Management [REM]

Version of module description: Gültig ab summerterm 2019

Module Level: Bachelor	**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:
Written exam (90 minutes): Students have to prove through the solution of problems from the scope of the lecture that they understand basics of resource and energy managements, that they are able to solve tasks and that they acquired the necessary verbal skill in the field. They need to prove their basic knowledge of trade, supply and sustainability of resources and energy carriers, management approaches and methods from engineering and natural sciences to solve problems of practical relevance and use the specific vocabulary to discuss emerging questions of resource and energy management. In addition, also aspects of interdisciplinary thinking and the transfer to other fields will be covered. Learning aids: pocket calculator

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic skills in business administration and economics

Content:
The module contains units covering the following topics:
- Environmental impacts of industrial and business activities,
- Societal, economic and legal frameworks of environmental protection,
- Motivation for businesses for applying environmental management approaches and methods,
- Environmental Management Systems,
- Methods and tools for environmental management, and
- Recent and emerging topics in environmental management.

Intended Learning Outcomes:
After successful completion of the module the students understand basics of resource and energy management. They are able to solve problems of practical relevance in this field in interdisciplinary teams and they discuss emerging questions concerning resources and energy management regarding the economic, supply and sustainability objectives.

Teaching and Learning Methods:
Format: Lecture with tutorial to introduce, train and deepen the contents of the module.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individulal assignments and presentation

Media:
Digital projector, board, flipchart, online contents, case studies

Reading List:
Recommended reading list:
- Geldermann (2014): Anlagen- und Energiewirtschaft, Vahlen.
Helyette (2008): Risk management in commodity markets, Wiley.
- James (2016): Commodity Market Trading and Investment, Palgrave.
- Kaltschmitt et al. Erneuerbare Energien, Springer.
- Ströbele, Pfaffenberger, Heuterkes (2012): Energiewirtschaft, Oldenbourg.
- Wellmer et al. (2019): Raw materials for future energy supply, Springer.
- Zweifel (2017): Energy Economics: Theory and Applications, Springer.
- as well as recent literature from German as well as international journals and current media.

Responsible for Module:
Magnus Fröhling magnus.froehling@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

CS0079BOK: Introduction in Hydraulics, Water and Waste Management | Introduction in Hydraulics, Water and Waste Management

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Continuous assessment during exercise units. Final written exam (multiple choice).

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
Combined lecture and exercises with the aim to provide basic knowledge in the #elds of water management, hydraulics, water and waste management at bachelor level in English language
The following topics will be addressed:
Hydraulics: Hydrostatics, Hydrodynamics (basic equations, conservation laws), pipe #ow (laminar and turbulent #ow, Darcy-Weisbach equation, friction factor, Moody-diagram) open-channel #ow (Manning-Strickler formula), gradually and rapidly varied #ow (hydraulic jump), , groundwater #ow (Darcy's Law, Laplace equation, hydraulic conductivity).
Water Management / Hydrology: Water balance and water cycle, surface and subsurface #ow processes, interrelations to hydraulic calculations (discharge, #ood routing, #ood protection
Waste Management: basic legal framework in the EU (waste framework directive, hierarchy), waste
de#nitions and characterisation; impacts on waste generation, environmental impact by waste management, waste treatment strategies and processes, waste disposal.

Intended Learning Outcomes:
Students will gain competence in solving applied hydraulic problems to support the design of e.g. sewer systems, water courses or #ood protection measures.

Students will know about principles and fundamental facts of water management (hydrologocial modelling and #ood risk management)
Students will know about fundamental aspects of waste management.

Teaching and Learning Methods:
Combination of lectures and exercises.

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Hydrologie und Wasserwirtschaft

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

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

Module Description

CS0080: Case Study Seminar in Supply Chain Management | Case Study Seminar in Supply Chain Management

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor	**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 students work together in teams and deal with a specific question from practice. For this purpose, the students explain the current state of science and describe the specifics of their own research work. They also formulate the procedure for dealing with their practical problem and outline the solution steps. The results are documented in a written project work (75% of evaluation) and a final 30 minutes presentation (25% of evaluation).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful complition of courses in Management Science and Sustainable Operations

Content:
The course conveys skills to develop solutions to specific problems in real business in case studies in the area of supply chain management. These relate to topics such as performance evaluation of supply chains, optimization of transport- and warehousing processes, inventory management, production processes and its planning.

Intended Learning Outcomes:
At the end of the module, students are able to structure, think through and develop solutions on their own. The intended learning outcomes of this course are to be able (1) to apply knowledge and skills from prior courses in supply chain management to a specific problem from real business (case study); (2) to structure a problem and its causes; (3) to assess appropriate approaches to solve the problem; (4) to develop an appropriate solution to the problem; (5) to communicate and discuss solutions in spoken and written language.

Teaching and Learning Methods:
The course combines different learning methods: (1) presentations by the instructor to brush up and deepen the participants' knowledge on supply chain management and convey approaches to solve case studies; (2) papers and presentations by the participants to document and communicate the problem and their solution; (3) coaching for the participants by experienced researchers to convey methodological skills to them; (4) written reports on peers' papers to develop the particpants' coummunication skills and for critical reflection.

Media:
Current literature, lectures, presentations

Reading List:
Günther, H.O., Tempelmeier, H. (2020), Supply Chain Analytics
Ghiani, G., Laporte, G., Musmanno R. (2013), Introduction to Logistics Systems Management, 2. Aufl., Wiley

Responsible for Module:
Prof. Alexander Hübner

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

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

Module Description

CS0080BOK: Mechanisms of Cell Regulation in Biotechnology Practical | Mechanisms of Cell Regulation in Biotechnology Practical

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
immanenter Prüfungscharakter: die Qualität der Arbeit im Labor, die Ergebnisse und die Präsentation und Diskussion der Ergebnisse am Ende #ießen zu gleichen Teilen in die Endnote ein.

Repeat Examination:

(Recommended) Prerequisites:

Content:
Anhand aktueller Beispiele aus der Forschung werden Analysen zur Charakterisierung des Sto#wechsels von biotechnologisch relevanten Organismen durchgeführt. Die Experimente werden gemeinsam mit den Studierenden geplant und ausgewertet

Intended Learning Outcomes:
Nach erfolgreicher Absolvierung dieses Praktikums sind die Studierenden in der Lage komplexe Experimente auf dem Gebiet der mikrobiellen Sto#wechselregulation zu entwerfen, durchzuführen und auszuwerten.
Die Studierenden erkennen den Zusammenhang zwischen den Anforderungen an Metabolic Engineering und Bioprozesstechnologie, um Produktionsstämme erfolgreich entwerfen und Die Studierenden wissen, wie Enzymatische Analysen geplant und durchgeführt werden, um Bioprozesse charakterisieren zu können.

Teaching and Learning Methods:
Labor

Media:

Reading List:

Responsible for Module:
BOKU - Department für Biotechnologie

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

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

Module Description

CS0081: Modelling and Optimization | Modellierung und Optimierung

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/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 examination is based on an exam (50% of evaluation) and a project work (50% of evaluation).

The 45min written exam tests the understanding of the modeling techniques discussed in the course. In the exam students have to answer questions, apply algorithms to solve problems, create mathematical models for small example problems, and discuss presented results. By this the students have to demonstrate that they have understood and can apply the mathematical models and methods to solve business planning problems.

The project paper serves the assessment of the understanding of the modeling language. For the project paper the participants get a randomly assigned fictive, extensive decision problem. For this problem, the following has to be prepared:
- a modeling of the problem as a mathematical program, as well as explanation of the program
- an implementation of the program in OPL
- a verbal and graphical explanation of the of the results for the original problem

The grading of the project paper is done by the following criteria:
- Correctness of modeling and implementation as well as of the results (60% of examination)
- Clarity, comprehensibility and efficiency of the implementation (30% of evaluation)
- correct language, typesetting and outer form of the paper (10% of evaluation)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Management Science (WI000275_E)

Content:
This course is about modeling, solving and analyzing planning and decision problems using mathematial concepts. The concepts are used across different industries, departments and organizations. The lecture will treat the Management Science approach to decision making in general and the following topics in particular: Basics of linear optimization, introduction to optimzation and corresponding languages (e.g., OPL), techniques of binary modeling, optimization of graph problems, problems with multiple objective functions, basic techniques of stochastic optimization and interfaces to other applications.

Intended Learning Outcomes:
After successful completion of the module students are capable of modelling planning problems. Students learn to model real life business problems e.g. from production and logistics by applying mathematical programming techniques. They can independently implement mathematical models by using an optimization language (e.g., OPL) on a PC and they are able to solve the models in Optimization Studio and interpret the results. Furthermore, they deepen their knowledge in several different modeling techniques.

Teaching and Learning Methods:
The module consists of a lecture and exercise courses, which are provided weekly. In the lecture the content is jointly developed with the students mainly by using slides. The exercise course repeats parts of the lecture contents by using examples and offering the opportunitis to program poblems individually. The excercises give the student the opportunity to pose questions and receive immediately help from the teaching assistant.

Media:
Script, Presentation slides

Reading List:
Kallrath, Josef and John M. Wilson: Business Business optimisation using mathematical programming. Macmillan, Basingstoke, 1997
Popp, Andreas: Modellierung und Optimierung mit OPL. epubli, 2015
Taha, Hamdy A.: Operations Research: an introduction. 8th ed., Pearson Prentice Hall, Upper Saddle River (NJ), 2007

Responsible for Module:
Prof. Alexander Hübner

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

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

Module Description

CS0081: Modelling and Optimization | Modelling and Optimization

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 examination is based on an exam (50% of evaluation) and a project work (50% of evaluation).

The 45min written exam tests the understanding of the modeling techniques discussed in the course. In the exam students have to answer questions, apply algorithms to solve problems, create mathematical models for small example problems, and discuss presented results. By this the students have to demonstrate that they have understood and can apply the mathematical models and methods to solve business planning problems.

The project paper serves the assessment of the understanding of the modeling language. For the project paper the participants get a randomly assigned fictive, extensive decision problem. For this problem, the following has to be prepared:
- a modeling of the problem as a mathematical program, as well as explanation of the program
- an implementation of the program in OPL
- a verbal and graphical explanation of the of the results for the original problem

The grading of the project paper is done by the following criteria:
- Correctness of modeling and implementation as well as of the results (60% of examination)
- Clarity, comprehensibility and efficiency of the implementation (30% of evaluation)
- correct language, typesetting and outer form of the paper (10% of evaluation)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Management Science

Content:
This course is about modeling, solving and analyzing planning and decision problems using mathematial concepts. The concepts are used across different industries, departments and organizations. The lecture will treat the Management Science approach to decision making in general and the following topics in particular: Basics of linear optimization, introduction to optimzation and corresponding languages (e.g., OPL), techniques of binary modeling, optimization of graph problems, problems with multiple objective functions, basic techniques of stochastic optimization and interfaces to other applications.

Intended Learning Outcomes:
After successful completion of the module students are capable of modelling planning problems. Students learn to model real life business problems e.g. from production and logistics by applying mathematical programming techniques. They can independently implement mathematical models by using an optimization language (e.g., OPL) on a PC and they are able to solve the models in Optimization Studio and interpret the results. Furthermore, they deepen their knowledge in several different modeling techniques.

Teaching and Learning Methods:
The module consists of a lecture and exercise courses, which are provided weekly. In the lecture the content is jointly developed with the students mainly by using slides. The exercise course repeats parts of the lecture contents by using examples and offering the opportunitis to program poblems individually. The excercises give the student the opportunity to pose questions and receive immediately help from the teaching assistant.

Media:
Script, Presentation slides

Reading List:
Kallrath, Josef and John M. Wilson: Business Business optimisation using mathematical programming. Macmillan, Basingstoke, 1997
Popp, Andreas: Modellierung und Optimierung mit OPL. epubli, 2015
Taha, Hamdy A.: Operations Research: an introduction. 8th ed., Pearson Prentice Hall, Upper Saddle River (NJ), 2007

Responsible for Module:
Hübner, Alexander; Prof. Dr. rer. pol.

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

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

Module Description

CS0081BOK: Meteorologie | Meteorologie

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:
schriftliche Klausur bestehend aus Multiple Choice Fragen (Rechenbeispielen, Theorie) sowie o#enen Fragen. Prüfungsmodalitäten werden in der Vorlesung bekanntgegeben.

Repeat Examination:

(Recommended) Prerequisites:

Content:
Aufbau der Atmosphäre, meteorologische Größen - Tages- und Jahresgang, globale Verteilungen und Messmethoden, Thermodynamik der Atmosphäre, Energiebilanz: Komponenten und Anwendungen im lokalen, regionalen und globalen Maßstab, Wasserkreislauf, atmosphärische Dynamik, Wettersysteme, Wetteranalyse und -vorhersage, Klimawandel, Klimaprojektionen

Intended Learning Outcomes:
Ziel
Das Bewußtsein um die Schönheit, Komplexität und Verwundbarkeit unserer Atmosphäre wecken. Das Versändnis für die Vorgänge in der Atmosphäre und deren Bedeutung für verschiedene Bereiche des Lebens heben. Grundkenntnisse vermitteln, die es gestatten, zu erkennen, bei welchen Fragestellungen meteorologische Überlegungen eingebunden werden müssen, und was quantitative Analysen und Abschätzungen erlernen.

Teaching and Learning Methods:
Frontalvorlesung

Media:

Reading List:
Folienskriptum wird den TeilnehmerInnen zur Verfügung gestellt.

Responsible for Module:
BOKU - Institut für Meteorologie und Klimatologie

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

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

Module Description

CS0082: Supply Chain Simulation | Supply Chain Simulation

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/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:
Because of the mediation of competences and the interactive character of the module using the supply chain simulation „The Fresh Connection“ several group presentations are part of the evaluation:
- Introductory presentation for a supply chain topic (30 minutes / 50% of the evaluation)
- Short presentation concerning decision alternatives within a round of the simulation (10 minutes / 20% of the evaluation)
- Presentations of the decisions made within the respective rounds of the simulation, the lessons learnt and the results (15 minutes / 30% of the evaluation)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Operations Research

Content:
The module is an innovative combination of mediation of theoretical background knowledge, practice and experience using the supply chain simulation „The Fresh Connection“. The topics in detail:
- Basics and decision making in supply chain management
- Supplier Management
- Demand Management
- Capacity and Production Management
- Inventory Management and Planning
- Supply Chain Mapping and component characteristics
- Supply Chain Strategy
- Variables and KPI‘s on strategic and tactical level

- External Collaboration

Intended Learning Outcomes:
The students will obtain a practice oriented overview of basics, decisions and interrelations in supply chain management. The students will achieve the ability to understand influencing factors and consequences of supply chain decisions with the help of the simulation “The Fresh Connection“. The students will achieve the competence for autonomous academic self study and application-oriented presentation of content. A focus of the mediation of competences is on work in cross-functional teams.

Teaching and Learning Methods:
Lecture, Web-based supply chain management simulation and learning environment, Self study and group work with presentation of result

Media:
Lecture, simulation software, presentations

Reading List:
Fisher, M.L. , What is the right supply chain for your product?, Harvard Business Review, March-April 1997
Christopher, M. , Logistics and Supply Chain Management, creating value-added networks, Prentice Hall, 2005
Chopra, S. and Meindl, Supply Chain Management, Pearson Education, third edition, 2007

Responsible for Module:
Prof. Alexander Hübner

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

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

Module Description

CS0082BOK: Microbial Ecology and Geomicrobiology | Microbial Ecology and Geomicrobiology

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:
Schriftlich und mündlich
Exam grades are combined by evaluation of student lectures and a written report.

Repeat Examination:

(Recommended) Prerequisites:
basic microbiology (from bachelor studies)

Content:
Microorganisms play a crucial role on our planet. Essentially, no place is free from microorganisms and everything that happens on the surface of earth involves the action of microorganisms.
This course informs about general principles of natural habitats for bacteria and unicellular eukaryotes, including mechanisms of adaptation, natural selection, interaction in communities and design of habitats. Further the population structures of example ecosystems, such as soil, swamp, surface/pelagic water, groundwater, sediment, hot springs, animal digestion tracts, plant surfaces and rhizosphere are examined.
The role of microbial life on a global scale will be analyzed. Examples for biogeochemical cycles will
be discussed, with emphasis on natural degradation processes of carbon based materials of natural and arti#cial origin. Questions how a dead tree is degraded in the forest, how a plastic an digest grass will be examined and compared. The course takes a look how complex (biochemical) tasks are distributed between many individual species and what this means for the resilience of the biosphere. Important methods to study microbial life in natural habitats will be presented and discussed all along. The course provides insight into our current understanding of environmental microbiology but also how such insight can be obtained.

Finally, this course will address the question of where well-known individual microbial species live and which role they presumably play in a wider context. Open questions and current knowledge gaps will be identi#ed and discussed.

Intended Learning Outcomes:
Ziel
By the end of this course, students will be able to:
• describe microbial populations and living conditions of microorganisms in all major habitats, as they are: surface soil including rhizosphere, deep soil, mineral surfaces, freshwater, oceans including deep sea and sediments, animal surfaces and digestion tracts.
• describe how complex biochemical tasks like the degradation of wood or plastic work, distributed over many microbial species
• understand microbe-microbe, microbe-plant and microbe-material interactions
• understand how microbial communities de#ne and run biogeochemical cycles
• identify the appropriate method to address a given question in environmental microbiology
• analyze the role of well-known microorganisms in nature

Teaching and Learning Methods:
Interaktion Lehrende und Lernende
This course is held as inverted classroom. It consists of pre-recorded lectures, moderated seminars
by students and discussions in the classroom.
At the time being the course is planned as online course, however, depending on the rules in WS it
- or parts - might be held in presence.

Media:

Reading List:

Responsible for Module:
BOKU - Department für Biotechnologie

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

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

Module Description

CS0083: Seminar Finance & Accounting: Financial Accounting | Seminar Finance & Accounting: Financial Accounting

The examination consists of a written seminar paper (60%), a paper presentation and a discussion in class (40%). By the written seminar paper, the ability is tested to independently analyze financial accounting issues theoretically and practically in a scientific way. By the paper presentation and the related discussion, the students learn how to summarize the paper topic and present it to an audience, as well as to stand a scientific discussion about the presented subject.

Version of module description: Gültig ab summerterm 2019

Module Level: Bachelor	**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 examination consists of a written seminar paper (60%), a paper presentation and a discussion in class (40%). By the written seminar paper, the ability is tested to independently analyze financial accounting issues theoretically and practically in a scientific way. By the paper presentation and the related discussion, the students learn how to summarize the paper topic and present it to an audience, as well as to stand a scientific discussion about the presented subject.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in financial accounting

Content:
In the seminar, students learn how
- to write a scientific paper
- to develop basic presentation skills
- to participate in a scientific discussion
- to analyze specific financial accounting topics
- to place specific issues a broader context
- to consider institutional differences and country-specific factors in a decision-making process

- national (HGB) and international accounting standards (IFRS) affect various capital market outcomes.

Intended Learning Outcomes:
Upon successful completion of the requirements for this seminar, students are be able to analyze a selected contemporary financial accounting issue and to communicate effectively in scientific writing. Moreover, students learn how to evaluate current developments in financial reporting and disclosure systems in regulatory national and international contexts.

Teaching and Learning Methods:
In the seminar, students will deepen their knowledge in scientific working methods and specific financial accounting areas. Presentations and discussions among participants of the seminar should provide a better overarching understanding of the facets of financial accounting. By presenting their scientific work, students learn to defend and assess scientific papers in front of an audience.

Media:
PowerPoint, films, internet, newspaper articles

Reading List:

Responsible for Module:
Prof. Janine Maniora

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

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

Module Description

CS0083BOK: Natur- und Landschaftsnutzung | Natur- und Landschaftsnutzung

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Schriftlich
Multiple Choice Fragen 40 Fragen Notenschlüssel: < 50%: nicht genügend 50 bis < 62,5%: genügend

Repeat Examination:

(Recommended) Prerequisites:
keine

Content:
Die Vorlesung erläutert einführend die Säulen des Natur- und Landschaftsschutzes mit den Schwerpunkten Schutzgebiete, Artenschutz, Landschafts- und eingri#sbezogene Planung. Darauf aufbauend werden ausgewählte Lebensraumtypen vorgestellt und Maßnahmen zu ihrer Erhaltung diskutiert. Bei den Lebensraumtypen handelt es sich um anthropogen entstandene Formen, die wesentlich den Charakter von Kulturlandschaften bestimmen. Hierzu zählen u.a. Streuobstwiesen, Feucht- und Streuwiesen, Feldgehölze und Hecken, Agrobiotope und urbane Sekundärbiotope (Stadtbiotope).

Intended Learning Outcomes:
- kennen die Säulen des Natur- und Landschaftsschutzes mit den Schwerpunkten Schutzgebiete, Artenschutz, Landschaftsplanung und Verträglichkeitsprüfung.
- können Traditionen und Trends im Natur- und Landschaftsschutz historisch einordnen.
- setzen die unterschiedlichen Aspekte von Natur- und Landschaftsschutz mit ihrer geschichtlichen
Entwicklung in Beziehung.

- kennen wichtige Lebensraumtypen wie Hecken, Streuobstwiesen, Agrobiotope, Weinbaulandschaften, Streuwiesen und Stadtbiotope.
- können die spezi#schen Herausforderungen und Maßnahmen zum Erhalt der Biodiversität in diesen Lebensräumen beurteilen.
- verstehen die Entwicklungen, die zum Rückgang der Biotop- und Artenvielfalt führen.
- ziehen das erworbene theoretische Wissen zur Beantwortung praxisnaher Fragestellungen zu Fachplanungen im Bereich Natur- und Landschaftsschutz heran.

Teaching and Learning Methods:
mit medialer Unterstützung

Media:

Reading List:
Die Folien zu jeder VO-Einheit können von BokuLearn heruntergeladen werden.

Responsible for Module:
BOKU - Institut für Landschaftsentwicklung, Erholungs- und Naturschutzplanung

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

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

Module Description

CS0084BOK: Negotiating Change: Simulating an International Conference for Sustainable Development | Negotiating Change: Simulating an International Conference for Sustainable Development

Version of module description: Gültig ab summerterm 2023

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

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:
BOKU

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

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

Module Description

CS0085BOK: On Site Solutions for Water Supply and Sanitation | On Site Solutions for Water Supply and Sanitation

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Schriftlich
due to the pandemic, the exams in February and March 2021 will be held as online oral exams

Repeat Examination:

(Recommended) Prerequisites:

Content:
Concepts and requirements for on-site solutions for water supply and sanitation in developed and developing countries.
- appropriate technologies and concepts
- towards sustainable implementation
- case studies

Intended Learning Outcomes:
Understanding concepts and requirements for on-site solutions for water supply and sanitation

Teaching and Learning Methods:

Media:

Reading List:
Lecture notes (presentations) will be provided in due time.

Responsible for Module:
BOKU - Institut für Siedlungswasserbau, Industriewasserwirtschaft und Gewässerschutz

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

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

Module Description

CS0086: Wood-Based Resources | Holz als Rohstoff

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:**
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:
Exam achievement shall be done in the form of a test. Product pathways of forestry and forest industry shall be reflected here. Classification of economic and ecological aspects of forestry and forest industry from cultivation to material and energetic use shall be explained by using examples of particular cases. Recognition of wood and wood materials shall be shown. The relation of knowledge of forestry and forest industry with regard to knowledge of different woods and wood utilisation will be evaluated at a ratio of 1 to 1. The answers require own formulations from the respective technical jargon of forestry and forest industry.
Type of exam: In writing. Exam duration: 90 minutes.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The module aims at providing in-depth knowledge to the students in the field of forestry and forest industry from harvest to the use of wood. Special emphasis is given to the interfaces concerning wood use (sawing, wood materials and paper industry) and energy wood production. In a further aspect differences of woods shall be addressed from a microscopic point of view through to their field of application in the manufacturing industry. Therefore, students learn to classify woods microscopically and macroscopically.

Intended Learning Outcomes:
After attending the module the student shall be able to characterise the product pathways in forestry from crop establishment through to material and energetic use of wood. He distinguishes different forms of economy and is able to classify them according to economic, social and

ecological aspects. He recognises differences of woods, knows various new products produced from wood and understands
their production paths and their markets.

Teaching and Learning Methods:
The course attendance of forestry and wood consists of a lecture and one exercise. For this purpose powerpoint presentations amd practical training material shall be used. A study trip to wood processing plants including lectures from qualified personnel providing information from experience on site with common rounds of questions provides in-depth knowledge of the production paths. A socalled wood block determination, i. e. the determination of wood by means of different genuine wood samples, will be performed by a magnifying glass 10x.

Media:
The following forms of media apply: Script, powerpoint, films, for determination exercises also branches and leaves of shrubs to be determined. Study trip to companies with guided tour of processing and treatment of wood. Determination of wood with a magnifying glass 10x.

Reading List:
Jörg van der Heide, 2011: Der Forstwirt. (The Forester) Publisher: Ulmer (Eugen); Auflage: 5th edition. (September
26, 2011)
Language: German
ISBN-10: 3800155702
ISBN-13: 978-3800155705; D. Fengel, G. Wegener: Wood Verlag Kessel, www.forstbuch.de

Responsible for Module:
Prof. Cordt Zollfrank

Courses (Type of course, Weekly hours per semester), Instructor:
Wood-based Resources (Lecture) (Vorlesung, 2 SWS)
Zollfrank C [L], Röder H, Zollfrank C

Wood-based Resources (Exercise) (Übung, 2 SWS)
Zollfrank C [L], Röder H, Zollfrank C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0086: Wood-based Resources | Wood-based Resources

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor/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:
Exam achievement shall be done in the form of a test. Product pathways of forestry and forest industry shall be reflected here. Classification of economic and ecological aspects of forestry and forest industry from cultivation to material and energetic use shall be explained by using examples of particular cases. Recognition of wood and wood materials shall be shown. The relation of knowledge of forestry and forest industry with regard to knowledge of different woods and wood utilisation will be evaluated at a ratio of 1 to 1. The answers require own formulations from the respective technical jargon of forestry and forest industry.
Type of exam: In writing. Exam duration: 90 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The module aims at providing in-depth knowledge to the students in the field of forestry and forest industry from harvest to the use of wood. Special emphasis is given to the interfaces concerning wood use (sawing, wood materials and paper industry) and energy wood production. In a further aspect differences of woods shall be addressed from a microscopic point of view through to their field of application in the manufacturing industry. Therefore, students learn to classify woods microscopically and macroscopically.

Intended Learning Outcomes:
After attending the module the student shall be able to characterise the product pathways in forestry from crop establishment through to material and energetic use of wood. He distinguishes different forms of economy and is able to classify them according to economic, social and

ecological aspects. He recognises differences of woods, knows various new products produced from wood and understands their production paths and their markets.

Teaching and Learning Methods:
The course attendance of forestry and wood consists of a lecture and exercises. For this purpose powerpoint presentations amd practical training material shall be used. A study trip to wood processing plants including lectures from qualified personnel providing information from experience on site with common rounds of questions provides in-depth knowledge of the production paths. A socalled wood block determination, i. e. the determination of wood by means of different genuine wood samples, will be performed by a magnifying glass 10x.

Media:
The following forms of media apply: Script, powerpoint, films, for determination exercises also branches and leaves of shrubs to be determined. Study trip to companies with guided tour of processing and treatment of wood. Determination of wood with a magnifying glass 10x.

Reading List:
D. Fengel and G. Wegener: Wood. Publisher: De Gruyter, https://doi.org/10.1515/9783110839654
Jörg van der Heide, 2011: Der Forstwirt. (The Forester) Publisher: Ulmer (Eugen); Auflage: 5th edition. (September
26, 2011)
Language: German
ISBN-10: 3800155702
ISBN-13: 978-3800155705; D. Fengel, G. Wegener: Wood Verlag Kessel, www.forstbuch.de

Responsible for Module:
Zollfrank, Cordt; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Wood-based Resources (Exercise) (Übung, 2 SWS)
Zollfrank C [L], Röder H, Zollfrank C

Wood-based Resources (Lecture) (Vorlesung, 2 SWS)
Zollfrank C [L], Röder H, Zollfrank C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0086BOK: Physiology of Crop Nutrition | Physiology of Crop Nutrition

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 30	**Contact Hours:** 90

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

Description of Examination Method:
Mündlich

Repeat Examination:

(Recommended) Prerequisites:

Content:
• De#nition and classi#cation of nutrients
• Nutrient uptake mechanisms by plant roots
• Translocation of nutrients within the plant
• The role of mineral nutrition in yield formation
• Interaction of source and sink organs
• Functions of macro- and micronutrients
• Bene#cial elements
• Nutrition, diseases and pests
• Diagnosis of nutrient de#ciency and toxicity symptoms

Intended Learning Outcomes:
After completing this course, the students are able to
• discuss the mechanisms of selective nutrient uptake by plant roots.
• explain nutrient translocation via xylem and phloem.
• describe the role of nutrients in yield formation.
• discuss the transport of photosynthates from source to sink organs and the regulation of sourcesink relationships, including the role of phytohormones in these processes.

• explain the appearance and formation of nutrient de#ciency and toxicity symptoms in important crop plants.

Teaching and Learning Methods:
mit medialer Unterstützung

Media:

Reading List:
• Marschner's Mineral Nutrition of Higher Plants, 3rd edition. Petra Marschner. 2012, Academic Press. ISBN 9780123849052
• Mineral Nutrition of Plants – Principles and Perspectives, 2nd edition. Emanuel Epstein and Arnold J. Bloom. 2004, Oxford University Press. ISBN 9780878931729
• Handbuch zur visuellen Diagnose von Ernährungsstörungen bei Kulturp#anzen, 3rd edition. Wilfried Zorn et al. 2016, Springer Spektrum. ISBN 3662491451
Basic reading in plant physiology:
• Plant physiology, 3rd edition. Lincoln Taiz and Eduardo Zeiger. 2002, Oxford University Press. ISBN 0878938230

Responsible for Module:
BOKU - Institut für Pflanzenbau

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

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

Module Description

CS0087: Electrical engineering | Elektrotechnik

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Examination is done with written exam of 90 minutes duration. Participants show that they are able to perform calculations using fundamental principles of electrical engineering (including DC and AC circuits). Furthermore, the participants demonstrate they understanding of energy conversion principles within the scope of electrical engineering by answering questions related to case examples.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Modules Mathematics I and II

Content:
Introduction to electrical engineering and electrical power engineering, comprising
- electrical charge, electrical field
- current, voltage, resistance
- electrical circuits, Kirchhoff's circuit laws
- magnetif field, induction
- power and energy associated with electromagnetism
- alternating current, pointer diagrams,
- semiconductors
- transformers, voltage levels
- electrical machines
- dangers from electrical currents

Intended Learning Outcomes:
After attending this module's courses the participants know the principles of electrical engineering and ist fundamental physical laws. They can apply fundamental equations of electrical engineering to perform calculations pertaining to electrical engineering and power engineering. In addition, the participants know about the various pathways for energy conversion relevant within electrical engineering.

Teaching and Learning Methods:
Lecture (oral presentation including writing on the board/document camera, PP media, cloze lecture notes), exercise (deepening of course contents with tutors) with work in small groups.

Media:
beamer presentation, cloze lecture notes, demonstration experiments

Reading List:
Fischer, R.; Linse, H. (2012): Elektrotechnik für Maschinenbauer, 14. Auflage, ISBN: 978-3-8348-1374-9;
Klaus Heuck, Elektrische Energieversorgung, 2010, Vieweg Teubner;
Panos Konstantin, Praxisbuch Energiewirtschaft, 2009, Springer;

Responsible for Module:
Josef Kainz josef.kainz@hswt.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

CS0087BOK: Ressourcennutzung und Ressourcenmärkte | Ressourcennutzung und Ressourcenmärkte

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Verständnis. Multiple Choice Prüfung und o#ene Fragen: Online Prüfung

Repeat Examination:

(Recommended) Prerequisites:
Mikro- und Makroökonomie

Content:
Nachhaltige Entwicklung steht vor der Herausforderung, natürliche Ressourcen so zu nutzen, dass
die Lebensgrundlagen zukünftiger Generationen weder durch Verknappung noch durch Verschmutzung gefährdet werden. Es ist aber nicht nur politisch, sondern auch theoretisch umstritten, wie eng die Restriktionen sind, welche die Nutzung natürlicher Ressourcen der gesellschaftlichen Entwicklung setzt - und wie mögliche Wege aus der multiplen Krise, die mit der derzeitigen Ressourcenverwendung verbunden ist (Klimawandel, Biodiversitätsverluste, globale Ungleichheit,…), aussehen können. Diese Lehrveranstaltung führt daher in unterschiedliche Theorien ein und zeigt ihre empirische Relevanz, um Studierende für eine fundierte Diskussion über Fragen nachhaltiger Ressourcennutzung vorzubereiten. Wir werden dafür neoklassische, ressourcenökonomische Theorie mit sozialökologischen und politikökologischen Ansätzen kontrastieren. Neben einer Einführung in die jeweiligen theoretischen Konzepte werden wir die gesellschaftliche Verwendung und Allokation von Ressourcen, insbesondere über Märkte, Ressourcenverwendung und eine Diskussion möglicher Zukunftsszenarien stehen am Ende der Lehrveranstaltung.

Intended Learning Outcomes:
Ressourcenökonomische und sozial-ökologische Ansätze zur Analyse der MenschUmweltbeziehungen verstehen
- Erkennen, in welchen Argumentationslinien nachhaltiger Entwicklung Elemente schwacher und starker Nachhaltigkeit enthalten sind
- Größenordnungen der Entnahme, des Handels und der Verwendung natürlicher Ressourcen einschätzen können
- Ein Verständnis für die ungleiche Verteilung von Ressourcennutzung und Emissionen entwickeln und verstehen, welche politischen Maßnahmen Ungleichheit verringern oder erhöhen können
- Die Rolle von Handel in Hinblick auf E#zienz, ungleichen ökologischen Tausch und Wohlfahrtserhöhung einschätzen können
- Historische Pfade der Ressourcennutzung verstehen und Zukunftsszenarien eines nachhaltigen Ressourcenverbrauchs bewerten können

Teaching and Learning Methods:
VORLESUNG
Vortrag, Kleingruppen- und Großgruppendiskussionen

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Soziale Ökologie

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

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

Module Description

CS0088: Measurement and Control | Mess- und Regelungstechnik

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**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:
Exam duration (in min.): 90. Proof of performance is provided in the form of a written examination. The students should prove that that essential concepts of measurement and control can be compiled, have been understood, can be presented in compressed form and procedures for evaluation can be applied. This implies in particular various aspects of error calculation, statistics, practical measurement technology, analysis of dynamic systems and controller design. Students should be able to create analytical solutions to problems from the mentioned subjects under time pressure and only with a simple calculator

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundations mathematics, electrical engineering

Content:
Theoretical basics of measurement technology, statistics, error propagation, practical effects, basics of electrical engineering for low-voltage measurement technology. Fundamentals of sensor technology and analog-to-digital conversion. Terms in control, modelling, laplace transformation, analysis of dynamical systems, feedback control and stability, controller design

Intended Learning Outcomes:
By completion of the module, the students are able to
- understand the problems of practical measurement with respect to accuracy,
- interpet measurement results,
- understand the basics of measurement in low voltage applications, the basics of sensoring, and the basics of analog-to-digital conversion,
- set up models of simple mechanical and electical systems in the time and frequency domain,

- analyse system properties like stabillity, transfer behavior, linearity,
- calculate system responsen with the help of the Laplace-Transformation,
- apply simple controller designs in the time and frequency domain and apply stability criteria,

Teaching and Learning Methods:
lectures with experiments and exercise

Media:
powerpoint/PDF-presentions, blackboard,
experiments

Reading List:
- Moeller, Fricke, Frohe, Vaske: Grundlagen der Elektrotechnik. B.G.Teubner, Stuttgart (2008).
- Bantel, M.: Grundlagen der Messtechnik Messunsicherheit von Messung und Messgerät. Fachbuchverlag Leipzig (2000).
- Schanz, G.W.: Sensoren. Hüthig Verlag, Heidelberg (2004)
- Föllinger, O.: Regelungstechnik. 10. Auflage, Hüthig-Verlag 2008. Ein Standard-Werk. Der Vorlesungsstoff wird bis auf wenige Ausnahmen gut abgedeckt.
- Lunze, J.: Regelungstechnik 1 Springer 1997. Lehrbuch in 2 Bänden, dessen 1. Band das den Stoff ebenfalls gut abdeckt. Viele Beispiele und Übungsaufgaben, auch mit MATLAB.
- Isermann, R.: Regelungstechnik I. Shaker Verlag 2002
- Horn, M. und Dourdoumas, N.: Regelungstechnik. Pearson Studium 2004

Responsible for Module:
Prof. Matthias Gaderer

Courses (Type of course, Weekly hours per semester), Instructor:
Mess- und Regelungstechnik (VO) (Vorlesung, 2 SWS)
Gaderer M [L], Putra L

Mess- und Regelungstechnik (UE) (Übung, 2 SWS)
Gaderer M [L], Putra L
For further information in this module, please click campus.tum.de or here.

Module Description

CS0088BOK: Ringvorlesung Forstwirtschaft | Ringvorlesung Forstwirtschaft

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:
Schriftlich
immanenter Charakter

Repeat Examination:

(Recommended) Prerequisites:

Content:
In insgesamt sechs Vorlesungseinheiten werden zentrale Themen der Österreichischen Bundesforste (ÖBf) abgehandelt. Die Themenblöcke werden von renommierten Persönlichkeiten aus unterschiedlichen Bereichen des Unternehmens vorgestellt. Die Lehrveranstaltung bietet die Möglichkeit zum persönlichen Kontakt und Gedankenaustausch mit den Vortragenden. Details zu den geplanten Vortragenden und Inhalten #nden Sie in der Terminliste der Lehrveranstaltung.
Die "Ringvorlesung Forstwirtschaft" wurde in enger Zusammenarbeit mit der Forst- und Holzindustrie gemeinsam mit dem BOKU-Department für Wald- und Bodenwissenschaften entwickelt und fachlich umgesetzt. Erstmals durchgeführt wurde sie im Wintersemester 2008/09.

Intended Learning Outcomes:
In der Ringvorlesung werden aktuelle forstwirtschaftliche Fragestellungen aus der Sicht unterschiedlicher Betriebe entlang der Wertschöpfungskette behandelt. Die ausgewählten Themen
verlangen einen stark interdisziplinären Ansatz. VorlesungsbesucherInnen sollen einen Einblick bekommen, welche Anforderungen die Praxis an die Wissenschaft stellt und welche Erwartungen künftige Arbeitgeber an BOKU AbsolventInnen haben.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
BOKU - Department für Wald- und Bodenwissenschaften

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

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

Module Description

CS0089BOK: Seminar in Energy and Process Engineering | Seminar in Energy and Process Engineering

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:
Mündlicher Vortrag (PowerPoint o.ä.) und Abstract über gewähltes Thema. In die Beurteilung #ießen Aufbau, Inhalt und Präsentation des Vortrags sowie die anschließende kritische Diskussion mit ein. Abstract: 20% Präsentation: 70% Diskussion / Fragerunde: 10% Nicht fristgerecht abgegebene Abstracts können nicht berücksichtigt werden! Die Vorbesprechung und die Präsentationen #nden online via Zoom-Videokonferenz statt. Einteilung: Siehe BOKU Learn Kurs!

Repeat Examination:

(Recommended) Prerequisites:

Content:
Jeder Teilnehmer soll an einem der angebotenen Termine, ein von Ihm ausgearbeitetes Thema in Form eines wissenschaftlichen Vortrags präsentieren und sich einigen Fragen stellen. Zudem soll zum Vortrag eine Zusammenfassung/ Abstract (1-2 DIN A4 - Seiten) als Handout für die Diskussionsteilnehmer erstellt werden, der die wichtigsten Punkte des Vortrags zusammenfasst.
Themen können von den Studierenden eingebracht werden oder der Themenliste entnommen werden. Vorschläge sind u.a.:
- Nachhaltige Energiegewinnung aus erneuerbaren Ressourcen
- Power-to-Heat
- Power-to-Gas
- Power-to-Mobility
- Einsatz nachwachsender Rohsto#e im Energiesektor
- Kälte- und Kühltechnik

Intended Learning Outcomes:
- Konfrontation der Studierenden mit Spezialthemen der Energie- und Verfahrenstechnik, Einschätzung und Beurteilung dieser Problemstellungen.
- Praktische Erfahrung zur Präsentation und Aufbreitung wissenschaftlicher Fragestellungen.
- Erstellung eines Abstracts / Zusammenfassung

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Verfahrens- und Energietechnik

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

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

Module Description

CS0090: Advanced Seminar Operations & Supply Chain Management: Advances in Retail Management | Advanced Seminar Operations & Supply Chain Management: Advances in Retail Management

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** German/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 examination consists of a written seminar paper, implemented optimization or simulation models as well as an oral presentation & discussion. The seminar paper should cover 15-20 pages and is written in the style of current publications of peer-reviewed journal articles. Accompanied with the seminar paper models have to be implemented to conduct numerical analyses, which will be handed in as a digital appendix. At the end of the module students present their work in a 45 minutes presentation. The written thesis and the presentation counts both with 50% of the final grading.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Prerequisite: One module in the field of Operations & Supply Chain Management and the MOS course.

Content:
The advanced seminar focuses on recent research progress on varying topics in service operations, e.g. omni-channel retailing, online retail management. Students identify strategic and operational relationships between supply chain management, marketing and service functions. Thereby, empirical research methods (such as regression models) are applied as well as mathematical optimization and simulation models (such as mixed-integer programming or discrete event simulation) to identify best practice relationships. Several topics with applications in assortment planning, last mile logistics, transportation, inventory management and procurement are available.

Intended Learning Outcomes:
The objective of the module is to equip the participants with the necessary skill and tools for a successful master thesis project.

Specifically, the aim is to be able to:

- Read and understand recent research contributions
- Pursue interesting research questions
- Conduct a literature study and/or numerical study and/or implementation
- Structure and organize research methods and results
- Write a seminar paper
- Present research findings and defend them in a discussion

Teaching and Learning Methods:
In an introductory session, the current theme of the module is explained by the lecturer and the various available seminar topics are elaborated in detail. Also information on relevant literature for the problem settings is introduced, wich forms the basis of the students' seminar papers. After the introductory session, students will work out the topic on their own, by using their abbilities of conducting literature research, mathematical modelling, programming and analyses. Throughout the whole time, they receive guidance from a supervisor of the chair. Different milestones are to be achieved at specific dates, such as a preliminary outline of the seminar paper, first research results and the final paper. Following the submission of the final paper, presentations and discussions of all students' seminar papers are conducted, usually spanning one or several days, where amongst others also presentation, moderation and discussion skills are trained.

Media:
Research paper; presentation slides

Reading List:
depending on scope of seminar, e.g., Hübner, A., Kuhn, H. & M.G. Sternbeck (2013): Retail demand and supply chain planning - An operations planning framework, in: International Journal of Retail and Distribution Management, 41 (7), S. 512–530

Responsible for Module:
Alexander Hübner

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

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

Module Description

CS0090BOK: Soil Physics and Chemistry | Soil Physics and Chemistry

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Schriftlich
Die Prüfung besteht aus zwei Teilen: Bodenphysik und Bodenchemie. Um die Prüfung positiv zu bestehen, sind in beiden Teilen je mindestens 55% der Gesamtpunktezahl zu erreichen. Im Fall eines negativen Abschneidens müssen beide Prüfungsteile wiederholt werden (nicht nur der negative Teil). Benotungsschema: >=90 Sehr Gut (1) >=80 Gut (2) >=70 Befriedigend (3) >=55 Genügend (4) <55 Nicht Genügend (5) Teil Bodenphysik Englische Fragen (o#ene Fragen) Teil Bodenchemie: in Englisch (Single und Multiple Choice) Prüfungsbeispiele (siehe "Prüfungsbeispiele") im BOKU Online verfügbar. Alle Fragen der Prüfung sind in englischer Sprache
zu beantworten. Die Verwendung eines Wörterbuchs ist nicht zulässig.

Repeat Examination:

(Recommended) Prerequisites:
Bodenkunde-, Physik- und Chemie-Kenntnisse auf Bachelorleve

Content:
Grundlagen der Bodenphysik und Bodenchemie
Teil Bodenchemie:
- Grundlagen der Bodenchemie
- Chemisches Verhalten ausgewählter Nähr- und Schadelemente (Sticksto#, Phosphor, Arsen, Cadmium) im Boden
- Grundlagen und ausgewählte Verfahren der Bodenanalytik

Intended Learning Outcomes:
Einführung in die Bodenphysik und Bodenchemie

Bodenphysik:
Lernergebnisse und Erworbene Kompetenzen:
Die Studierenden
- kennen grundlegende Gesetzmäßigkeiten der (Boden-)physik
- verstehen die wesentlichen Konzepte und Parameter der Bodenphysik und können diese auf bestimmte bodenphysikalischen Fragestellungen anwenden
- sind mit dem Verhalten ausgewählter Parameter (Bodendichten, -volumina, -strukturformen, Bodenwasser, -luft, -farbe vertraut
Detaillierte Lernziele (Learning outcomes) des Teils Bodenphysik sind in den Lernunterlagen (verfügbar im BOKULearn) de#niert.
Bodenchemie:
Lernergebnisse und Erworbene Kompetenzen:
Die Studierenden
- kennen grundlegende Gesetzmäßigkeiten der (Boden-)chemie
- verstehen fundamentale Konzepte der Bodenchemie und können diese auf bestimmte bodenchemische Fragestellungen anwenden
- sind mit dem Verhalten ausgewählter Elemente (P, N, As, Cd) im Boden vertraut
- kennen grundlegende Verfahren der Bodenanalytik und ihre Bedeutung
Detaillierte Lernziele (Learning outcomes) des Teils Bodenchemie sind in den Lernunterlagen (verfügbar im BOKULearn) de#niert.

Teaching and Learning Methods:
mit medialer Unterstützung

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Bodenforschung

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

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

Module Description

CS0091BOK: Statistics with R | Statistics with R

Version of module description: Gültig ab summerterm 2023

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
2	60		

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

Description of Examination Method:
Schriftlich

Repeat Examination:

(Recommended) Prerequisites:

Content:
R ist ein #exibles und umfangreiches Statistikprogramm, das frei verfügbar ist. Es handelt sich dabei um eine Freeware-Implementierung der Statistiksprache S, die dem Programmpaket S-PLUS
zugrunde liegt.
Die in der Vorlesung gebotene Einführung wendet sich an Statistiknutzer, die an einer solchen nichtkommerziellen Alternative zu herkömmlichen Programmen wie SAS, SPSS oder eben S-PLUS
interessiert sind. Die Schwerpunkte sind:
* Einführung in grundlegende Programmeigenschaften (Installation, Bedienung, Dokumentation; Dateneingabe und -verwaltung; Gra#k)
* Demonstration der Sprachmöglichkeiten an Hand von elementaren statistischen Verfahren (statistische Tests, Regressionsanalyse, Varianzanalyse)
* Überblick über Erweiterungsmöglichkeiten (Au#nden und Installation von Erweiterungsmodulen; Automatisierung eigener Analysen; Online-Ressourcen) an Hand von weiterführenden statistischen Verfahren (z.B. Clusteranalyse) in Absprache mit den Teilnehmern.

Intended Learning Outcomes:
Die Teilnehmer sollen in die Lage versetzt werden, das Programmpaket R in seinen grundlegenden
Funktionen zu beherrschen und einfache statistische Auswertungen (numerisch und graphisch) vorzunehmen. Darüber hinaus soll es jedem Teilnehmer gelingen, sich nach Bedarf und Interesse in die weiterführenden Möglichkeiten des Programms einzuarbeiten.

Teaching and Learning Methods:
Teilnehmer, die an einem Zeugnis interessiert sind, können entweder selbständig ein statistisches Problem aus ihrem Interessensbereich wählen, oder ein solches vom Vortragenden erhalten. Das jeweilige Problem ist mit R zu bearbeiten, und die angewendeten Verfahren und erzielten Ergebnisse sind Gegenstand eines Prüfungsgesprächs. Termine werden individuell vereinbart. Die Note ergibt sich aus der Benotung der Übungsbeispiele.

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Statistik

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

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

Module Description

CS0092: Wind Power | Windkraft [Wind]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 82	**Contact Hours:** 38

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

Description of Examination Method:
The basics of energy generation from wind are assessed in a written examination (60 minutes). Multiple-choice questions can also be asked. The students prove that they have understood the technology of wind turbines and that they are able to carry out calculations on the design, energy yield and economic efficiency of wind turbines. They also show that they have understood the special problems in the project planning phase as well as during operation within the framework of legal requirements, the requirements for nature and species protection as well as the local acceptance of wind power use and ecology and acceptance and that they are able to evaluate plants and sites in this respect.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics in Mathematics and Physics
Basics in Energy Technology

Content:
This module teaches in-depth knowledge about energy generation from wind power. The technology is described using the following points:
- Physical basics
- Designs and system components
- Planning, construction and operation
- Power output and energy supply
In addition to the technical characteristics of the plants, the module also focuses on their effects on the environment, legal framework conditions and economic

Intended Learning Outcomes:
Having attended the module, the students will be able to characterize and recognize different types of wind turbines and to understand them from a technical and energetic point of view. The students understand the processes involved in planning, erecting and operating wind turbines and are able to evaluate turbines from an economic and ecological point of view.

Teaching and Learning Methods:
The module consists of lecture and exercise. The contents of the lectures are primarily conveyed by the lecturers and through presentations. The students should get a well-founded insight into the topic. The exercises cover on the one hand technical calculations on wind turbines, on the other hand the different aspects of turbine project planning, in particular economic and ecological aspects, as well as acceptance by public. Among other things, plan and role plays in groups are planned to achive this goal. Some of the exercises are to be prepared by the students themselves, others are to be carried out as face-to-face exercises. This should encourage students to work independently and to deal more intensively with the respective topics. Simulation and role-playing games help students to gain a deeper understanding of the opportunities and problems in the field of wind power technology.

Media:
PowerPoint, blackboard, publications

Reading List:
Peter Schaffarczyk, Wind Power Technology, Springer, 2023, ISSN 1865-3529, ISSN 1865-3537 (electronic)

Responsible for Module:
Doris Schieder Doris.schieder@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Windkraft Übung (Übung, 1 SWS)
Schieder D [L], Schieder D, Widmann A

Windkraft Vorlesung (Vorlesung, 1,5 SWS)
Schieder D [L], Schieder D, Widmann A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0092: Wind Power | Wind Power [Wind]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 82	**Contact Hours:** 38

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

Description of Examination Method:
The basics of energy generation from wind are assessed in a written examination (60 minutes). Multiple-choice questions can also be asked. The students prove that they have understood the technology of wind turbines and that they are able to carry out calculations on the design, energy yield and economic efficiency of wind turbines. They also show that they have understood the special problems in the project planning phase as well as during operation within the framework of legal requirements, the requirements for nature and species protection as well as the local acceptance of wind power use and ecology and acceptance and that they are able to evaluate plants and sites in this respect.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics in Mathematics and Physics
Basics in Energy Technology

Content:
This module teaches in-depth knowledge about energy generation from wind power. The technology is described using the following points:
- Physical basics
- Designs and system components
- Planning, construction and operation
- Power output and energy supply
In addition to the technical characteristics of the plants, the module also focuses on their effects on the environment, legal framework conditions and economic

Intended Learning Outcomes:
Having attended the module, the students will be able to characterize and recognize different types of wind turbines and to understand them from a technical and energetic point of view. The students understand the processes involved in planning, erecting and operating wind turbines and are able to evaluate turbines from an economic and ecological point of view.

Teaching and Learning Methods:
The module consists of lecture and exercise. The contents of the lectures are primarily conveyed by the lecturers and through presentations. The students should get a well-founded insight into the topic. The exercises cover on the one hand technical calculations on wind turbines, on the other hand the different aspects of turbine project planning, in particular economic and ecological aspects, as well as acceptance by public. Among other things, plan and role plays in groups are planned to achive this goal. Some of the exercises are to be prepared by the students themselves, others are to be carried out as face-to-face exercises. This should encourage students to work independently and to deal more intensively with the respective topics. Simulation and role-playing games help students to gain a deeper understanding of the opportunities and problems in the field of wind power technology.

Media:
PowerPoint, blackboard, publications

Reading List:
Peter Schaffarczyk, Wind Power Technology, Springer, 2023, ISSN 1865-3529, ISSN 1865-3537 (electronic)

Responsible for Module:
Schieder, Doris; Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Windkraft Vorlesung (Vorlesung, 1,5 SWS)
Schieder D [L], Schieder D, Widmann A

Windkraft Übung (Übung, 1 SWS)
Schieder D [L], Schieder D, Widmann A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0092BOK: Wasserrecht | Wasserrecht

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Mündlich
Prüfungsmodus: Vorlesungsprüfung Die Prüfung wird mündlich am Institut für Rechtswissenschaften abgehalten. Der genaue Veranstaltungsraum wird rechtzeitig bekanntgegeben. Dauer der Prüfung: 30 min Die Prüfung ist ö#entlich. Regeln: - Zur Prüfung ist ein
Lichtbildausweis mitzubringen. - Hilfsmittel, wie LV Unterlagen, dürfen während der Prüfung NICHT verwendet werden.

Repeat Examination:

(Recommended) Prerequisites:
Es werden keine facheinschlägigen Vorkenntnisse vorausgesetzt

Content:
Die Lehrveranstaltung bietet eine Einführung in das Wasserrecht und einen Überblick über mit dem Wasserrecht in Zusammenhang stehende wichtige Bereiche des Umweltrechts.
Behandelt werden zunächst die Grundprinzipien des Rechts und darauf aufbauend der rechtliche Rahmen auf nationaler, europäischer und internationaler Ebene mit besonderem Fokus auf wasserrechtliche Bewilligungsverfahren, die Verleihung von Wasserrechten, Gewässerschutz und Gewässerpolizei sowie Vorsorge- und Sanierungsinstrumente.

Intended Learning Outcomes:
Nach Absolvierung der Lehrveranstaltung sind Studierende imstande Fragen des Wasserrechts zu erkennen und zu bewerten.

Teaching and Learning Methods:
Frontalvorlesung

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Rechtswissenschaften

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

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

Module Description

CS0093: Energy and process engineering lab | Grundlagenpraktikum Energie- und Verfahrenstechnik

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**Language:** German	**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:
In the practical course, the exam is taken by positively elaborated written internship reports (for each experiment about 5 pages of report). Thereby the correct presentation of the theoretical basics, the reproduction of the experimental procedure and the correct data evaluation are essential. Thereby the students show that they understand basic processes and principles of energy and process engineering and that they can design and calculate corresponding transformations. The students prove that they can execute and evaluate metrological experiments in small groups (2-3 persons).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Chemical reaction engineering, Fluid separation processes, Energy Technology

Content:
Basic operations of energy and process engineering, especially from the chemical, thermal and mechanic range e.g. destillation or particle distribution analysis.

Intended Learning Outcomes:
After graduation of the practical course, the students know basic processes and principles of process engineering (e.g. heat transfer and separation techniques). They know how to design and calculate a chemical, physical or mechanic transformation. Furthermore, they know the process steps which are necessary for it.

Teaching and Learning Methods:
The acquisition of basic principles is prepared by handed out literature.
The student learns the theoretical understanding, the basic engineering of the experiment and the correct use of the installed measurement technique through the graduation of the practical course. The acquisition of these properties is proved at the day of the experiment and comfirmed by producing a report. Thereby also the ability is reviewed to evaluate and report data correctly. The content and the number of experiments are chosen from a of multiplicity of basic operations and rely on the available laboratory equipment.

Media:
Practical course script, laboratory equipment

Reading List:
Practical course script

Responsible for Module:
Jakob Burger burger@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagenpraktikum Energie- und Verfahrenstechnik (Praktikum, 5 SWS)
Burger J [L], Burger J
For further information in this module, please click campus.tum.de or here.

Module Description

CS0093BOK: Project Citizen Science | Project Citizen Science

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 90	**Contact Hours:** 90

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

Description of Examination Method:
Seminararbeit (100%)

Repeat Examination:

(Recommended) Prerequisites:
abgeschlossenes Bachelorstudium, Grundlagen der Statistik, Grundlagen wissenschaftliches Arbeiten

Content:
Citizen Science, also die aktive Einbindung der Bevölkerung in wissenschaftliche Projekte, ermöglicht die Beantwortung komplexer Fragestellungen im Bereich der Nachhaltigen Entwicklung (z.B. zur Erreichung der UN - Sustainable Development Goals). Viele Projekte aus der Ökologie befassen sich mit dem Thema der Biodiversität. In dieser Lehrveranstaltung bietet sich den Studierenden die einmalige Gelegenheit in einem der bekanntesten Citizen-ScienceProjekte Österreichs mitzuarbeiten und dabei eigene Fragestellungen zu bearbeiten und zu
beantworten. Die Studierenden können damit einerseits einen Beitrag zum Schutz der Biodiversität leisten, und andererseits selbst zur aktuellen Forschung beitragen.
Als Rahmen dient das Projekt Roadkill (www.roadkill.at), das bereits seit einigen Jahren sehr erfolgreich von den Lehrveranstaltungsleitern durchgeführt wird und bereits den BOKU Nachhaltigkeitspreis 2017 gewonnen hat, sowie für den Bundestierschutzpreis 2018 nominiert war. Die Studierenden bekommen in den einführenden Einheiten einen Einblick in das laufende Projekt und identi#zieren mögliche Forschungsfragen, die sie mit den im Projekt gesammelten Daten beantworten möchten. Wichtige Skills (z.B. Literatursuche und -verwaltung) werden ebenfalls behandelt um in mehreren angeleiteten Schritten in Form von Gruppenarbeiten die selbst gewählten Forschungsfragen in einer wissenschaftlichen Arbeit zu beantworten.

Intended Learning Outcomes:
1. Erlernen des wissenschaftlichen Arbeitens (Hypothesenerstellung, Methodende#nition, Datenanalyse, Verfassen einer Publikation) in einem preisgekrönten Citizen-Science-Projekt
2. Verbessertes Verständnis und Einblick in das Arbeiten mit Citizen-Science

Teaching and Learning Methods:
Gruppenarbeit
im Fokus steht selbstständiges Arbeiten angeleitet und unterstützt durch regelmäßige Projektmeetings und Methodenvermittlung

Media:

Reading List:

Responsible for Module:
BOKU

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

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

Module Description

CS0094: Bachelor's Thesis | Bachelor's Thesis

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 12	**Total Hours:** 360	**Self-study Hours:** 180	**Contact Hours:** 180

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

Description of Examination Method:
The module is completed with the preparation and positive evaluation of the Bachelor´s Thesis (depending on selection of topics 10 to 100 pages).

Repeat Examination:

(Recommended) Prerequisites:
120 credits, including all compulsory modules from the first four semesters, according to the module plan of the respective bachelor's program

Content:
consolidation of the knowledge of a specific topic in the area of technology of biogenic resources which is arbitrary in consultation with the supervisor / consolidation of practical skills in the lab / presentation of a research-based topic

Intended Learning Outcomes:
After completion of the module, the students are able to work self-reliant on simple scientific problems on the basis of scientific methods and analytical thinking. The can present their results in a conclusive way, are able to discuss and to draw conclusions.

Teaching and Learning Methods:
During the Bachelor´s Thesis, the students work on a scientific problem. At this juncture amongst others literature research as well as lab work and presentations are used. The actual teaching and learning methods depend on the respective problem and have to be discussed with the supervisor for each single case.

Media:
Specialist literature, software and so on

Reading List:
in consultation with the supervisor

Responsible for Module:
Jakob Burger burger@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

CS0094BOK: Hygiene | Hygiene

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Schriftlich
Die schriftliche Prüfung umfasst insgesamt 6 Fragen, die nach einem Punkteschema (jeweils max. 5 Punkte) bewertet werden. Je nachdem, wie umfassend die Fragen beantwortet oder Fragen zu besonders wichtigen Themen falsch oder nicht beantwortet wurden, wird die Prüfung benotet, so dass sich letztlich die Gesamtnote nicht nur aus der reinen Punktezahl ergibt, d.h. es auch zu Punkteabzügen kommen kann. Benotungsschema: <15 Punkte: 5 (Nicht genügend) 15-19 Punkte: 4 (Genügend) 20-23 Punkte: 3 (Befriedigend) 24-27 Punkte: 2 (Gut) 28-30 Punkte: 1 (Sehr gut) .

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse in Mikrobiologie sind empfohlen

Content:
Ausgehend von der De#nition des Begri#es "Hygiene" und damit von einer sehr interdisziplinären Sichtweise wird die Relevanz der Hygiene für die Lebensmittelsicherheit und damit letztendlich für die Gesundheit des Menschen mit folgender Schwerpunktsetzung behandelt: Begri#sde#nition, aktueller Status und Trends in der Lebensmittelsicherheit, rechtlicher Rahmen (globale und europäische Rechtsgrundlagen), Lebensmittel und Qualität, Toxine, pathogene Mikroorganismen, Infektion/Intoxikation, Grundlagen der Epidemiologie und des ö#entlichen Gesundheitswesens, Mykotoxine, Viren, Prionen, Parasiten, Rückstände und Kontaminanten, biogene Amine, Allergene, Grundbegri#e der Toxikologie, Schädlinge, Lebensmittelverderb, Reinigung und Desinfektion.

Intended Learning Outcomes:
AbsolventInnen dieser Lehrveranstaltung beherrschen die Grundlagen der Hygiene als
AbsolventInnen dieser Lehrveranstaltung beherrschen die Grundlagen der Hygiene als zentralen Aspekt für die Lebensmittelsicherheit. Ihre Detailkompetenzen liegen im interdisziplinären Verständnis der vielfältigen Hygieneaspekte. Ihnen sind die dominierenden Gefahren betre#end die Sicherheit von Lebensmittel bekannt. Weiters verfügen sie über einen Einblick in die rechtlichen Grundlagen der Lebensmittelhygiene auf europäischer und internationaler Ebene.

Teaching and Learning Methods:
mit medialer Unterstützung

Media:

Reading List:
Die Vorlesungsunterlagen und ergänzende Unterlagen stehen als PDF-Dateien zum Download aus BOKUlearn zur Verfügung. Das dazu notwendige Passwort wird in der 1. Vorlesungseinheit bzw. via BOKUlearn bekannt gegeben.

Responsible for Module:
BOKU

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

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

Module Description

CS0095: Cooperative Design Project | Kooperative Projektarbeit

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 210	**Contact Hours:** 30

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

Description of Examination Method:
The module will be completed with the production and grading of a written final report. In the report, the students shall describe problem, solution approach, individual assignments within the project team, calculations, and analyses in concise fashion. The personal contributions of the individual student shall be described. In regular meetings with the supervisor, the individual contributions are monitored.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals of Thermodynamics, Basics on renewables utilization

Content:
The task describes a technical problem in the field of the use of biogenic resources for which the team has to find a solution. Examples are e.g:
1. preparation of a concept and design of a biogas plant for an agricultural business
2. Feasibility Study on the conversion of high performance packaging in space application from fossil-based plastics to bio-based plastics

Intended Learning Outcomes:
"After successful participation in the module, the students will be able to
- understand and classify the cooperation in a team with heterogeneous knowledge base,
- apply the basics of process and energy engineering to practical problems
- discuss the interrelationships between different aspects of a project (time management, balancing, interaction, objectives),
- present self-developed balance sheets and calculation results in text form,
- carry out work in a hierarchical organisation"

Teaching and Learning Methods:
The module consists of a project work, which is carried out in a cooperative team between Bachelor and Master students. Depending on the given task, the team size is 2-6 persons. The Master students assume the role of project leaders and are responsible for formulating and achieving the project goals. The Bachelor students carry out research, analysis and calculations and are supported by the Master students if required. Progress, role identification, and individual involvement are monitored in regular meetings with the supervisor.

Media:
Will be adapted to task at the project start by the supervisor

Reading List:
Rowe, S. (2015). Project Management for Small Projects, 2nd Edition. Oakland: Berrett-Koehler Publishers.
Specific literature will be announced by the supervisor before the project starts.

Responsible for Module:
Jakob Burger burger@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
(Kooperative) Projektarbeit (Praktikum, 8 SWS)
Gaderer M [L], Herdzik S, Huber B, Meilinger S, Putra L, Schenker M, Veiltl P
For further information in this module, please click campus.tum.de or here.

Module Description

CS0095BOK: Food Toxicology | Food Toxicology

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
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:
Schriftlich
schriftliche Prüfung. In der schriftlichen Prüfung werden 40 Single-Choice-Fragen und eine o#ene Frage gestellt. Für jede Single-Choice-Frage gibt es 1 Punkt, die o#ene Frage wird mit 10 Punkten bewertet. Insgesamt gibt es 50 Punkte, und 60 % sind erforderlich, um eine positive Note zu erhalten. Die Verteilung der Punkte für die jeweiligen Noten ist wie folgt: Grade Points 1 46 – 50 2 41 – 45 3 36 – 40 4 30 – 35 5 0 - 29

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Die Toxikologie ist eine interdisziplinäre Wissenschaft, in der – neben chemisch-biologischen Grundlagen, die dem Studenten der Lebensmitteltechnologie weitgehend vertraut sein dürften – auch pharmakologische und medizinische Inhalte eine wichtige Rolle spielen. Ausgehend von der Paracelsus'schen De#nition eines Giftes, wonach die Giftwirkung eines Sto#es von der Dosis abhängig ist, werden die folgenden Themen behandelt:
Toxikologische Begri#e, wie Dosis, Dosis-Wirkungskurve, LD50-Wert, Schwellenwert u.ä.; medizinisch-physiologische Grundlagen der für die Toxikologie wichtigsten Organe, wie Leber, Niere, Nerven, Herz-Kreislauf-System, Haut oder Lunge; Toxikokinetik, Fremdsto#metabolismus, Cytotoxikologie, Kanzerogenese, Immuntoxikologie, Reproduktionstoxikologie, Epidemiologie, Risikoabschätzung, Grenzwerte, Untersuchungsmethoden, gesetzliche Grundlagen.
Neben der exemplarischen Behandlung ausgewählter Lebensmitteltoxine in verschiedenen Kapiteln schließt die Vorlesung mit einem breit gefächerten Überblick über Toxine, die im

Zusammenhang mit Lebensmitteln auftreten, ab

Intended Learning Outcomes:
Nach erfolgreicher Absolvierung der Vorlesung sind die Studierenden mit den Grundlagen der Lebensmitteltoxikologie vertraut. Die Vorlesung soll einen Überblick über Toxine im Allgemeinen und giftige Lebensmittelinhaltssto#e sowie Giftsto#e, die bei der Lagerung, Verarbeitung oder Zubereitung entstehen, sowie deren Wirkungen geben. Als Voraussetzung zum Verständnis dieser Wirkungen werden Aufnahme-, Verteilungs- und Ausscheidungsmechanismen sowie metabolische Umsetzungen und die von den Sto#en selbst oder ihren Metaboliten verursachten Wirkungen, wie z.B. cytotoxische E#ekte, Mutagenität, Kanzerogenität, Störungen des Immunsystems Beein#ussungen der Reproduktion erläutert.
Nach Absolvierung dieser Vorlesung beherrschen die Studierenden u.a. folgende Fähigkeiten
- Sie können das toxikologische und medizinische Vokabular, das im Zusammenhang mit Lebensmittelinhaltssto#en, Kontaminanten und Zusatzsto#en von Bedeutung ist, verstehen und anwenden.
- Sie kennen die wichtigsten Giftsto#e, die in Lebensmitteln natürlicherweise vorhanden sind oder im Laufe der Produktion, Lagerung und Zubereitung auftreten können, und deren Wirkungen.
- Sie verstehen wichtige Mechanismen toxischer Wirkungen und können diese nachvollziehen.
- Sie kennen den Aufbau und die Funktion wichtiger Organe als Orte des Metabolismus von Fremdsto#en und als Zielorgane toxischer Wirkungen.
- Sie verstehen den Ein#uss von Giftsto#en auf wichtige Krankheitsverläufe, wie die Kanzerogenese oder die Beein#ussung des Immunsystems.
- Sie kennen die Bedeutung von Grenzwerten und deren Zusammenhänge mit toxischen Dosen bzw. Konzentrationen.
- Sie haben einen Überblick über wichtige Untersuchungsmethoden der Toxikologie.

Teaching and Learning Methods:
Frontalvorlesung

Media:

Reading List:
Unterlagen sind auf der Homepage von BokuLearn, zum Downloaden bereit gestellt.

Responsible for Module:
BOKU - Institut für Lebensmittelwissenschaften

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

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

Module Description

CS0096: Advanced Empirical Research Methods | Advanced Empirical Research Methods

Version [illegible]

such impact assessment. In addition, students are able to understand statistics in scientific literature (peer reviewed journals).

Teaching and Learning Methods:
The lecture and exercise will be done using Powerpoint and Stata. In addition, scientifically published studies will be integrated into the lectures. In the exercise, the students themselves analyze data sets that are made available. The results of the case studies are then discussed and questioned individually and / or in groups from different perspectives by the students. Scientific publications using statistical analysis are analyzed and discussed by the students.

Media:
Presentations, slide scripts, Articles

Reading List:
Kleiber & Zeileis (2008): Applied Econometrics with R, Springer; Angrist & Pischke (2009): Mostly Harmless Econometrics: An Empiricist's Companion, Princeton Univers. Press.

Responsible for Module:
Faße, Anja; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Empirical Research Methods (Lecture) (Vorlesung, 2 SWS)
Faße A [L], Faße A

Advanced Empirical Research Methods (Exercise) (Übung, 2 SWS)
Faße A [L], Richter S, Shayo G
For further information in this module, please click campus.tum.de or here.

Module Description

CS0096BOK: Food Biotechnology | Food Biotechnology

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:** 60	**Contact Hours:** 90

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

Description of Examination Method:
Schriftlich
Die schriftliche Prüfung umfasst insgesamt sechs Fragen (max. 5 Punkte/Frage). Je nachdem, wie umfassend die Fragen beantwortet oder Fragen zu besonders wichtigen Themen falsch oder nicht beantwortet wurden, werden die Punkte vergeben. < 15 Punkte: 5 (nicht bestanden) 15-19 Punkte: 4 19,5-23 Punkte: 3 23,5-27 Punkte: 2 27,5-30 Punkte: 1

Repeat Examination:

(Recommended) Prerequisites:
Grundlegende mikrobiologischen, biochemische und molekularbiologische Kenntnisse

Content:
A) Einleitung: Lebensmittel, Biotechnologie; Geschichte der LBT; Wechselbeziehung von LMBT und Ernährungswissenschaften, Welt-Ernährungssituation
B) Fermentierte Lebensmittel; Haltbarmachen von Lebensmitteln; Bacteriocine; Starterkulturen
C) fermentierte Milchprodukte - Gemüse - Fleisch
D) Mikrobielle Polysaccharide: Xanthan, Polysaccharide von Milchsäurebakterien
E) aktuelle Entwicklungen; metabolic engineering von Milchsäurebakterien
F) Aminosäureproduktion durch Corynebacterium und E. coli; metabolic engineering
G) Pilze, Einzeller-Protein, Fruchtkörper
H) Alkohol; Bier und Sake
I) Organische Säuren: Funktion, Zitronensäure, Milchsäure, Gluconsäure
J) Süßsto#e: Zuckeralkohole, Aspartam, Oligosaccharide
K) Geschmacks- und Geruchssto#e: Vanillin, Frambinon
L) mikrobielle Öle und Fette
M) Enzyme; Anwendungen in der Milch- und Backindustrie

Intended Learning Outcomes:
Nach erfolgreicher Absolvierung dieser Lehrveranstaltung sind die Studierenden mit den Strategien, Anforderungen und Möglichkeiten der Lebensmittel-Biotechnologie vertraut. Aufbauend auf mikrobiellen, biochemischen und molekularbiologischen Grundlagen ermöglicht die Vorlesung die Vernetzung lebensmittelbiotechnologischer Fragestellungen mit aktuellen technologischen, grundlagen-orientierten und legislativen Aspekten

Teaching and Learning Methods:
mit medialer Unterstützung

Media:

Reading List:
Die Vorlesungungsunterlagen werden via BOKU learn zur Verfügung gestellt.
Ergänzungsunterlagen werden ebenfalls via BOKU learn zur Verfügung gestellt.
Empfehlungen für Fachbücher werden zur Vorlesungsbeginn besprochen.

Responsible for Module:
BOKU - Institut für Lebensmitteltechnologie

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

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

Module Description

CS0097: Advanced Environmental and Resource Economics | Advanced Environmental and Resource Economics

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:
The examination will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Micro- and Macroeconomics

Content:
Many environmental issues, such as climate change, need to be considered globally. This course conveys concepts of optimal use of renewable and non-renewable resources in ex-ante viewing. In addition, the economics of water, energy markets, and natural resources such as fish and forest are deepened. Foundations of the New Institutional Economics illustrate the problem of the tragedy of common goods. Indicator systems such as Driver-Pressure-Stae-Impact-Response show the importance and complexity of environmental and sustainability measurement at national and international level.

Intended Learning Outcomes:
After attending the module, students will understand the role of renewable and non-renewable resources in the economy. Students can differentiate between the highest possible economic and sustainable return. They understand the functioning of energy and water markets. The students gain an understanding of the New Institutional Economy, especially land ownership and the sustainable use of public goods. In addition, students understand the measurement

of sustainability at the international and national level as well as the mathematical laws for the calculation of aggregated indices.

Teaching and Learning Methods:
The lecture and the seminar will be done by PowerPoint. In addition, articles from newspapers and journals are integrated into the lectures. In the seminar the students develop their own current case studies and discuss them from different perspectives based on the learned concepts and theories from the lecture. Classroom experiments are carried out for selected topics. Web lectures by internationally renowned experts and researchers will be integrated into the lecture.

Media:
Presentations, slide scripts, Articles, online lecture examples

Reading List:
Pearce, D. and R.K. Turner(1990). Economics of Natural Resources and the Environment. Johns Hopkins Univ Pr.
Tietenberg, T. and L. Lewis (2008). Environmental & Natural Resource Economics. Addison Wesley; 8 edition.

Responsible for Module:
Faße, Anja; 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

CS0097BOK: Scientific Computing | Scientific Computing

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
- Two tests - Home assignments (every week) & presentations in class: assignments are solved in groups, but have to be presented individually

Repeat Examination:

(Recommended) Prerequisites:
- Ability to handle your operating system, including the handling of #les and directories
- Basic maths skills
- Functions, derivative of a function (e.g. a polynomial)
- Plotting the graph of a function
- coordinate systems, how to calculate distances between points in 2d and 3d
- Theorem of Pythagoras, cosine/sine functions
- Statistical basics: how to calculate mean, max, min of a set of samples
- Programming skills are not required, but will be helpful of course

Content:
This class will introduce the students to Python, one of the most widely used languages in scienti#c programming and data analysis today. The class will #rst introduce students to the basic concepts of programming in Python. Afterwards, students will learn about the Python scienti#c ecosystem including numpy, scipy and pandas. The machine learning library scikitlearn will also be presented. The class focuses on programming techniques relevant for applications in research.

Intended Learning Outcomes:
After taking the class, students
- are able to write code in Python with a particular focus on data analysis

- understand the concept of functions
- know the Python Scienti#c Ecosystem, including Numpy, Scipy, and Pandas
- are able to download and load data using Python
- are able to plot data and calculate basic statistics using Python

Teaching and Learning Methods:
Vorlesung mit integrierten Übungen
The class is split into three parts:
- Interactive lecture with integrated exercises
- Exercises at home (each week)
- Presentation of exercises in class

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Nachhaltige Wirtschaftsentwicklung

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

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

Module Description

CS0098: Operations Research | Operations Research

Version of module description: Gültig ab winterterm 2023/24

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:
Assessment takes the form of a written examination. In that examination, students must demonstrate their ability to formulate and solve decision models with appropriate methods. Type of assessment: in writing duration of assessment: 90 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Bachelor Business administration; advanced knowledge of mathematics and statistics

Content:
The module is divided into six distinctive areas:

Part 1: Basic Concepts
Part 2: Quantitative Modelling
Part 3: Linear Optimization
Part 4: Graph Theorie
Part 5: Integer and Combinatorical Optimization
Part 6: Dynamic Optimization

Intended Learning Outcomes:
The course introduces fundamental and advanced methods for modeling and solution of business problems with concepts from Operations Research (OR). Students will be introduced to using quantitative methods for planning and decision-making in companies and societies. Students will apply analytical methods of problem-solving and decision-making that is useful in the management of organizations.

Teaching and Learning Methods:
Lecture (theory), tutorials with group work and presentation

Media:
Seminaristic tution using beamer, overhead projector, flipchart

Reading List:
Hilier, F. and Lieberman, G., Introduction to Operations Research, McGraw-Hill, 2009
Kallrath, J and Wilson, J. M., Business Optimisation using mathematical Programming, London (Macmillan) 1997
Winston, W.: Operations Research - Applications and Algorithms. 4th ed. (internat. student ed.), Belmont, Calif. (Duxbury), 2004.
Taha, H. A., Operations Research, 7th ed., Upper Saddle River, N.J. (Prentice Hall) 2003.
Domschke, W., Drexl, A., Klein, R., Scholl, A, Einführung in Operations Research, Berlin (Springer) 2015.
Domschke, W. et al., Übungen und Fallbeispiele zum Operations Research, Springer, Berlin–Heidelberg, 2015

Responsible for Module:
Hübner, Alexander; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Operations Research (Vorlesung mit integrierten Übungen, 4 SWS)
Hübner A [L], Hübner A, Riesenegger L
For further information in this module, please click campus.tum.de or here.

Module Description

CS0098BOK: Mathematics for Engineers | Mathematics for Engineers

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Participation (presentation / discussion) and written exam.

Repeat Examination:

(Recommended) Prerequisites:

Content:
Lecture:
Introduction to mathematical software in applied sciences. How to implement basic and advanced mathematical methods, such as for solving di#erential equations or the analysis of experimantal data, in the mathematical program Mathematica.
Exercises:
The participants present mathematical questions or problems that they encounter in their study or research, such as di#erential equations or experimental data from their planned or ongoing master thesis or PhD thesis. They then use mathematical software, as discussed in the lecture, for these questions and problems.

Intended Learning Outcomes:
Successful application of mathematical methods by using mathematical software.

Teaching and Learning Methods:
Vorlesung mit integrierten Übungen

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Mathematik

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

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

Module Description

CS0099BOK: Programming with Python | Programming with Python

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Students will be evaluated based on 2 midterm programming exams (each 30 %) and a #nal project aimed at writing a user-friendly script able to parse, analyze and plot a given dataset of interest (40 %)

Repeat Examination:

(Recommended) Prerequisites:

Content:
Inhalt
Nowadays, the ability to design and write computer programs is becoming an indispensable skill. Among di#erent programming languages, Python has become popular and widely used in the #eld of biosciences, for its readability, object-oriented programming and many available libraries that extend its functionality. This course is aimed at bachelor, master and PhD students with no or very little programming experience, who want to learn basics of programming and how to write scripts using Python language. It is primarily oriented at developing practical programming skills and basics of problem-solving (algorithmic thinking) using computer programs, with the main focus on data analysis and plotting. Python modules and packages (e.g. numpy, matplotlib) will be introduced and used.
Topics
• General programming ideas
o Data types
o Flow control
o Functions
o String manipulation (parsing, formatting)

• Plotting and analysis of scienti#c data
o Spectroscopic data
o Protein sequences, structures
• Python packages
o Matplotlib
o Numpy
o Scipy
o Pandas

Intended Learning Outcomes:
Students will learn how to write basic scripts using Python, as well as how to use selected Python modules, primarily aimed at data analysis and plotting.
• Construct and develop basic blocks of tasks (functions).
• Write Python code to analyze and plot scienti#c data.
• Design and write programs to solve a given problem.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Molekulare Modellierung und Simulation

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

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

Module Description

CS0100: Microbial and Plant Biotechnology | Microbial and Plant Biotechnology [MPBioTech]

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:
In order to check whether students have understood and are able to apply the principles and relevant methods and techniques of biotechnological production processes, the students answer questions about production processes and fermentation strategies, as well as on important methods and applications in plant biotechnology in a written exam (90 min) and prove that they have understood the correlations of metabolism. Allowed tools are calculators.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals of Biology or of cell and microbiology from the Bachelor's courses

Content:
In the lecture microbial biotechnology relevant topics and techniques of microbial biotechnology are presented. This includes the quantitative description of the metabolic performance of microorganisms, industrially relevant substrate sources, metabolic engineering strategies as well as examples of industrial production processes (e.g.: alcohols, amino and organic acids).
In the lecture plant biotechnology the most important model and crop plants in biotechnology are presented, classified and their morphological and physiological properties are emphasized. Major questions, methods and solutions will be discussed with thier pros and cons. Some of the topics to be discussed: legal framework, major appilcation of current plant genetic engineering, the Arabidopsis model system, snovel concepts for yield and quality improvement. One focus is on the challenges for agriculture caused by climate change and sustainable solutions.

Intended Learning Outcomes:
Upon successful completion of the module, students will be familiar with the principles and techniques of relevant microbial bioprocesses. The students have acquired knowledge of fermentation processes and are able to develop strategies for process control for selected product classes. The students have learned to quantitatively describe microbial growth and fermentation processes. The students have acquired in-depth knowledge of relevant production processes for selected products of industrial biotechnology and understand their importance for the development of sustainable chemistry. Also, the students know the most important methods and applications in plant biotechnology and are able to assess them.

Teaching and Learning Methods:
The contents of the lectures are conveyed by a talk of the lecturer, based on PowerPoint presentations. The blackboard might additionally be used to explain more complex relationships. To a limited extent, this can be supplemented by self-study of the literature mentioned in the lecture.

Media:
PowerPoint, whiteboard

Reading List:
Microbiology – an evolving science, J. L. Slonczewski, J. W. Foster, W W Norton & Co Inc, 4th edition, ISBN: 978-0-393-61403-9 (available in the library)
Molecular Biology of the Gene, I. D. Watson, T. A. Baker, A. Gann, M. Levine,
Losick, Pearson, 7th edition, ISBN-13: 978-0321762436 (available in the library)
Biotechnology, R. D. Schmid, C. Schmidt-Dannert, Wiley-VCH, 1st edition,
ISBN: 978-3-527-33515-2 (available in the library, eBook)
Industrial Microbiology, D. B. Wilson, H. Sahm, K.-P. Stahmann, M. Koffas,
Wiley-VCH, 1st edition, ISBN: 978-3-527-34035-4 (available in the library)
Industrial Biotechnology – Products and Processes, C. Wittmann, J. Liao,
Wiley-VCH, volume 4, ISBN: 978-3-527-34181-8 (available in the library, eBook)
Industrial Biotechnology – Microorganisms, C. Wittmann, J. Liao,
Wiley-VCH, volume 4, ISBN: 978-3-527-34179-5 (available in the library, eBook)
Campbell Biology N. A. Campbell, L. A. Urry, M. L. Cain, S. A. Wasserman, P. V. Minorsky, J. B. Reece, Pearson, 11th edition (2018) (available in the library)

Responsible for Module:
Blombach, Bastian; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Microbial Biotechnology (Vorlesung, 2 SWS)
Blombach B [L], Blombach B

Applied Microbiology and Metabolic Engineering (Lecture) (Vorlesung, 2 SWS)
Blombach B [L], Blombach B, Glawischnig E

Plant Biotechnology (Lecture) (Vorlesung, 2 SWS)
Glawischnig E [L], Glawischnig E
For further information in this module, please click campus.tum.de or here.

Module Description

CS0100BOK: Field Crops | Ackerbauliche Nutzpflanzenkunde

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4.5	**Total Hours:** 135	**Self-study Hours:** 45	**Contact Hours:** 90

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

Description of Examination Method:
Written
written examination (multiple choice test)

Repeat Examination:

(Recommended) Prerequisites:
Solid knowledge of botany

Content:
Cereal crops:
bread wheat, durum wheat, rye, oat, barley, triticale, maize and more
Legumes:
soybean, pea, faba bean, chickpea, lentil, lupins etc.
Oilseed crops:
OIlseed rape, sun#ower, oil pumpkin, linseed, poppy and others
Tuber and root crops:
potato, sugar beet, Jerusalem artichoke, fooder beets
Others:
Fibre crops, industria crops, energy crops, #eld vegetables, medical and spice crops ach of the #ve groups of #eld crops is outlined using a problem-based approach of knowledgetransfer. Plant breeding, agronomy and phytopathology issues will be covered for each crop
group.

Intended Learning Outcomes:
Students are achieving an overview of individual #eld crop species and groups of #eld crops with respect to plant breeding, agronomy and plant pathology. Students are able to link

agronomic knowledge with plant breeding and phytopathology issues for problem solving.

Teaching and Learning Methods:
Lecture, hands-on demonstrations at the BOKU experimental farm.

Media:

Reading List:
A script of this course will be available online.
BECKER, H., 2011, P#anzenzüchtung, 2. Au#., Verlag Eugen Ulmer, Stuttgart. UTB 1744.
DIEPENBROCK, W., F. ELLMER & J. LEON 2005, Ackerbau, P#anzenbau und P#anzenzüchtung.
Verlag Eugen Ulmer, Stuttgart. Serie UTB.
FISCHBECK, G., W. PLARRE & W. SCHUSTER (Hrsg.), 1985, Lehrbuch der Züchtung landwirtschaftlicher Kulturp#anzen, Band 2, Spezieller Teil. Zweite, neubearbeitete Au#age, Verlag Paul Parey, Berlin.
DIEPENBROCK, W., G. FISCHBECK, K.-U. HEYLAND & N. KNAUER, 1999, Spezieller P#anzenbau. 3.,
neubearb., ergänzte Au#age, Verlag Eugen Ulmer, Stuttgart. UTB 111.
HALLMANN, J., QUADT-HALLMANN, A. & A. VON TIEDEMANN, 2007, Phytomedizin Grundwissen
Bachelor, Eugen Ulmer KG, Stuttgart. UTB 2863.
KÜHNE, S., BURTH, U. & P. MARX, 2006, Biologischer P#anzenschutz im Freiland. Eugen Ulmer KG, Stuttgart.

Responsible for Module:
BOKU- Institute of Agronomy

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

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

Module Description

CS0101: Renewables Utilization | Renewables Utilization

Version of module description: Gültig ab winterterm 2020/21

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:
Assessment takes a written examination (90 minutes), with students to unterstand and to apply structure, transformation and use of different renewable resources. Students are required to answer questions using individual formulations and outline structures and reactions. In addition, sample calculations are to be worked out.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic lectures in chemistry; Basics on renewables utilization

Content:
Various types of ingredients of renewable raw materials: sugars, polysaccharides, fats and oils, amino acids, proteins, terpenes, aromatics. The following topics will be dealt with in more detail: structure, composition, occurrence, properties, analysis and type of added value or use in various examples.

Intended Learning Outcomes:
After completion of the modules, students understand the chemical composition of renewable resources as well as their production and application. Using this knowledge students are able to explain the respective advantages and disadvantages as well as analyze the underlying physical, chemical and biotechnological principles of their conversion into valuable products.

Teaching and Learning Methods:
Lecture and accompanying tutorial including individual work on specific examples.

Media:
Presentation, script, examples and solutions

Reading List:

Responsible for Module:
Rühmann, Broder; Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Renewables Utilization (Exercise) (Übung, 2 SWS)
Rühmann B

Renewables Utilization (Lecture) (Vorlesung, 2 SWS)
Sieber V [L], Rühmann B, Sieber V
For further information in this module, please click campus.tum.de or here.

Module Description

CS0101BOK: Plant and Environment Technology | Plant and Environment Technology

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

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

Description of Examination Method:
written test, seminar attendance

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Chemische Industrie, Anlagen- und Umweltmanagement

Content:
Safety Technique, Industrial Organisation, Economic Industrial Management, Maintenance, Planning of Plants, Structure of Personell, Equipments and Plants for Environmental Protection, Developments regarding Environmental Protection (production-oriented, product-oriented, service-oriented), Environmetal Management EMAS and ISO, Ecological Industrial Balance, Material Flow Balances, Cleaner Production.

Intended Learning Outcomes:
students are aware of environmental problems involved in the development, design and operation of process plants.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Holztechnologie und Nachwachsende Rohstoffe

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

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

Module Description

CS0102: Introduction to Game Theory | Introduction to Game Theory [IGT]

Version of module description: Gültig ab summerterm 2024

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:
Learning outcomes are verified in a written exam (90 minutes). Students show the extent to which they have understood the taught game-theoretical definitions and terminology. They show to which extend they are able to use games in order to model problems from economics and engineering. They are also expected to apply important solution concepts to concrete games and answer comprehension questions concerning the properties and the advantages and disadvantages of the different solution concepts.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Module Mathematics (WZ1601) or Advanced Mathematics 1 (CS0175)

Content:
Cooperative and non-cooperative games, solution concepts for cooperative games, core, Shapley value, solution concepts for non-cooperative games, pure Nash equilibria, mixed Nash equilibria, dominant strategies, Bayesian games, modeling concrete case studies related to sustainability as cooperative and non-cooperative games

Intended Learning Outcomes:
Students have aquired basic theoretical and practical knowledge on cooperative and non-cooperative games. They know the basic definitions and terminology and are able to model sustainability-related problems from economics and engineering as games. Students know the most important solution concepts for cooperative games (such as the core and the Shapley value) and non-cooperative games (such as Nash equilibria and dominant strategies). They have gained a good understanding of these concepts and are able to analyze concrete games by using them.

Teaching and Learning Methods:
Lectures introduce basic knowledge; tutorials practice modelling of application problems as games and applying solution concepts to concrete examples.

Media:
Lectures given as presentations (projector and/oder blackboard), tutorials with group work and exercise sheets

Reading List:
Manfred J. Holler, Gerhard Illing, Stefan Napel - Einführung in die Spieltheorie, 8. Auflage, Springer Gabler, 2019.
Steven Tadelis - Game Theory: An Introduction, Princeton University Press, 2013.
M. J. Osborne and A. Rubinstein - A Course in Game Theory, MIT Press, 1994

Responsible for Module:
Thielen, Clemens; 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

CS0102BOK: Geotechnics | Geotechnics

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**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:
Written
The exam will be in the form of homework. Each student will solve a problem connected with three topics, using personalized data, which you will receive from the IGT secretariat. You will find detailed information in BOKUlearn.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in soil mechanics

Content:
• Constitutive models and numerical analysis
• Advanced laboratory testing
• Dams and embankment
• Slope stability analysis
• Geotechnical earthquake engineering

Intended Learning Outcomes:
Know-how in advanced topics of soil mechanics and geotechnical engineering; hand-on experience of geotechnical software; design practice

Teaching and Learning Methods:
multimedia-supported

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Geotechnik (IGT)

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

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

Module Description

CS0103BOK: Agricultural Production and Policy Impact Modelling | Agricultural Production and Policy Impact Modelling

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**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:
Seminar paper

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
The course captures:
1. Introduction to GAMS (http://www.gams.com)
- Sets and Conditions
2. Impact Analysis
- Farm Level Analysis
- Regional Analysis
- Sector (partial equilibrium models) Analysis
3. Evaluation of alternative Natural Resource Uses
4. Static and Dynamic Comparative Analyses
5. Fixing Unbounded and Infeasible Models using GAMSCHK
6. Efficient Report Writing of Model Results

Intended Learning Outcomes:
The objective of this course is to:
- carry out impact analyses in the #eld of agricultural, resource and environmental economics using GAMS (General Algebraic Modeling Systems),
- learn good model building in GAMS,

- build models for farm, regional, partial equilibrium, natural resource, and environmental analyses,
- interpret and synthesize model results.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Nachhaltige Wirtschaftsentwicklung

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

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

Module Description

CS0104: Biogenic Polymers | Biogenic Polymers [Bioplar]

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**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:
During the seminar, students independently work on a topic from the field of biogenic polymers, and give an oral presentation. Group work is optional. Assessment requires an oral examination (30 minutes). Students demonstrate their knowledge of physico-chemical properties of biogenic polymers as well as possible applications. Students are able to develop options for chemical synthesis and analysis of physico-chemical properties of bioplastics. No further tools are allowed in the examination.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in "Basics in Chemistry" and knowledge of materials and chemical compounds, or comparable knowledge on chemistry and physics.

Content:
The module deals with structure and function of natural bio-macromolecules (in particular polysaccharids and proteins). Furthermore, basics of biogenic polymers will bei discussed in the view of polymers holding potential for applications in future technology. The topic of chemical synthesis and derivatization of bioplastics for use in industry is introduced (e.g. cellulose derivatives). Special focus is set on the development of options for chemical synthesis and its competent application. Physico-chemical properties of bioplastics as well as their characterization is central to the lecture.
The seminar takes the form of a journal club with students independently work on reserach papers and their presentation to fellow students.

Intended Learning Outcomes:
After participation, students are able to classify different kinds of bioplastics with respect to their possible application. They are competent to evaluate the production processes of biopolymers used in technology and can classify them according to their profile of properties. The module enables students to decide on appropriate synthesis methods to meet specific requirements in the industry. Students will also be able to use physico-chemical analysis methods in a competent way.

Teaching and Learning Methods:
Lecture (talks given by teaching staff using PowerPoint media, books and additional written document), seminar (independent work on a topic including a presentation, peer instruction and constructive criticism)

Media:
Presentations, slide notes

Reading List:
Endres, H.J., Seibert-Raths, A., Technische Biopolymere, Carl Hanser Verlag, München, 2009

Responsible for Module:
Zollfrank, Cordt; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Biogenic Polymers (Seminar) (Seminar, 1 SWS)
Zollfrank C [L], Helberg J

Biogenic Polymers (Lecture) (Vorlesung, 2 SWS)
Zollfrank C [L], Zollfrank C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0104BOK: Fish Farming and Aquaculture | Fish Farming and Aquaculture

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
written

Repeat Examination:
Next semester

(Recommended) Prerequisites:
general Hydrobiology

Content:
Fish farming and Principles in Aquaculture
International aquaculture
Austrian case studies
Modern aquaculture tecnologies

Intended Learning Outcomes:
- Describe the role of aquaculture at Austrian, European and worldwide level, both ecologically and economically;
- Understand principles in aquaculture
- Discuss various methods in fish farming

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
BOKU - Institute of Hydrobiology and Aquatic Ecosystem

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

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

Module Description

CS0105: Modelling and Optimization of Energy Systems | Modelling and Optimization of Energy Systems [MOES]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** German/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:
Assessment is done in a written examination (90 minutes). Participants of the course solve programming tasks to demonstrate that they are able to apply the methods aquired in the course. By answering questions related to case examples they show that they have learned to put things into their proper context.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Bachelor modules Mathematics, Physics, Numerical Methods;
Basic knowledge in Energy technology; basic programming experience (ideally with Matlab)

Content:
Basics of Modelling and Simulation:
- physical models
- data-based models (look-up tables, polynomials, neural networks)
- methods for generating models
Fundamental optimization methods:
- linear optimization (linear regression)
- nonlinear optimization

Intended Learning Outcomes:
After attending the course the participants understand basic methods for creating models, simulation and optimization. In addition, they are able to apply these methods by creating appropriate program code in Matlab. Furthermore, the participants acquire Matlab programming experience.

Teaching and Learning Methods:
The module consists of a lecture and an excercise. Lectures include presentations whose content is deepened by solving excercise problems autonomously. In order to improve the learning outcome, participants work at homework excercise problems. These are discussed in the next lecture.

Media:
PP presentation, whiteboard, demonstration of programs

Reading List:
S. R. Otto & J.P. Denier, An Introduction to Programming and Numerical Methods in MATLAB, Springer, London, 2005
O. Nelles, Nonlinear System Identification, Springer, Berlin, 2010

Responsible for Module:
Kainz, Josef; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Modelling and Optimization of Energy Systems (Vorlesung mit integrierten Übungen, 4 SWS)
Kainz J [L], Kainz J
For further information in this module, please click campus.tum.de or here.

Module Description

CS0106: Introduction to Graphs and Networks | Einführung in Graphen und Netzwerke [EGN]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** irregularly
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:
Assessment takes an oral form (25 minutes). Students show the extent to which they have understood the taught definitions and terminology from the field of graphs and networks. They show to which extend they are able to use networks in order to model problems from science and engineering. They are also expected to use appropriate methods to solve fundamental optimization problems on networks. Students demonstrate their understanding of these methods when answering comprehension questions.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Module Mathematics (WZ1601) or Advanced Mathematics 1 (CS0175)

Content:
Directed and undirected graphs and networks, paths and cycles, connected components, minimum spanning tree problem, shortest path problem, Prim's algorithm, Kruskal's algorithm, Dijkstra's algorithm, matchings, Modeling with graphs and networks

Intended Learning Outcomes:
Students have aquired basic theoretical and practical knowledge in the field of graphs and networks. They know the basic definitions and terminology and are able to use networks in order to model problems from science and engineering. Students know fundamental optimization problems on networks such as the minimum spanning tree problem or the shortest path problem as well as the most important methods for solving these problems. They have gained a good understanding of these methods, can choose appropriate methods among them, and can apply these to case examples.

Teaching and Learning Methods:
Lectures introduce basic knowledge; tutorials practice modelling using networks and the application of methods for solving optimization problems on networks.

Media:
Lectures given as presentations (projector and/oder blackboard), tutorials with group work and exercise sheets

Reading List:
André Krischke und Helge Röpke - Graphen und Netzwerktheorie, Carl Hanser Verlag, 2015.
Sven Krumke und Hartmut Noltemeier - Graphentheoretische Konzepte und Algorithmen, 3. Auflage, Vieweg+Teubner Verlag, 2012.
Ravindra Ahuja, Thomas Magnanti, James Orlin - Network Flows, Prentice Hall, 1993.

Responsible for Module:
Prof. Clemens Thielen

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

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

Module Description

CS0106BOK: Advanced Methods in Remote Sensing: Machine Learning and Cloud Computing | Advanced Methods in Remote Sensing: Machine Learning and Cloud Computing [CS0106BOK]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Continuous assessment and final project

Repeat Examination:

(Recommended) Prerequisites:
Basics programming skills. Basic principles of remote sensing and image classification.

Content:
1 Introduction to statistics and algebra.

2 Machine learning:
2.1 Feature extraction: Spatial, spectral and temporal.
2.2 Clustering: k means.
2.3 Supervised classification methods:
2.5.1. Decision trees (DT).
2.5.2. Random Forest (RF).
2.5.3. Support Vectors Machines (SVM).
2.5.4. Neural networks (NN).
2.4 Real world example I: Object detection and classification using very high spatial resolution.
2.5 Real world example II: Classification of hyperspectral images.

3 From local laptop to Cloud computing: Google Earth Engine.
3.1 Real world example III: Spring plant phenology products.
3.2 How to use machine learning in the cloud: remote sensing classification.

3.3 Real world example IV: Classification using very high spatial resolution data.
3. 3 Real world example V: mapping phenoregions and correlating temperature and satellite based phenometrics

Intended Learning Outcomes:
During this course the students will learn to design and deploy machine learning lgorithms as well as to use cloud computing for the analysis of remote sensing images. Both machine learning and cloud computing topics are explained using real world cases.

Teaching and Learning Methods:
Lectures with case studies.

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Geomatik - Izquierdo-Verdiguier, Emma

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

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

Module Description

CS0107: Introduction to Graphs and Networks | Einführung in Graphen und Netzwerke

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
Assessment takes an oral form (25 minutes). Students show the extent to which they have understood the taught definitions and terminology from the field of graphs and networks. They show to which extend they are able to use networks in order to model problems from science and engineering. They are also expected to use appropriate methods to solve fundamental optimization problems on networks. Students demonstrate their understanding of these methods when answering comprehension questions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module Mathematics (WZ1601)

Content:
Directed and undirected graphs and networks, paths and cycles, connected components, minimum spanning tree problem, shortest path problem, Prim's algorithm, Kruskal's algorithm, Dijkstra's algorithm, matchings, Modeling with graphs and networks

Intended Learning Outcomes:
Students have aquired basic theoretical and practical knowledge in the field of graphs and networks. They know the basic definitions and terminology and are able to use networks in order to model problems from science and engineering. Students know fundamental optimization problems on networks such as the minimum spanning tree problem or the shortest path problem as well as the most important methods for solving these problems. They have gained a good understanding of these methods, can choose appropriate methods among them, and can apply these to case examples.

Teaching and Learning Methods:
Lectures introduce basic knowledge; tutorials practice modelling using networks and the application of methods for solving optimization problems on networks.

Media:
Lectures given as presentations (projector and/oder blackboard), tutorials with group work and exercise sheets

Reading List:
André Krischke und Helge Röpke - Graphen und Netzwerktheorie, Carl Hanser Verlag, 2015.
Sven Krumke und Hartmut Noltemeier - Graphentheoretische Konzepte und Algorithmen, 3. Auflage, Vieweg+Teubner Verlag, 2012.
Ravindra Ahuja, Thomas Magnanti, James Orlin - Network Flows, Prentice Hall, 1993.

Responsible for Module:
Prof. Clemens Thielen

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

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

Module Description

CS0107BOK: Environmental Biotechnology Seminar | Seminar in Environmental Biotechnology [CS0107BOK]

Version of module description: Gültig ab winterterm 2023/24

Module Level:	Language:	Duration:	Frequency:
Bachelor/Master	English	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
2	60	30	30

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

Description of Examination Method:
- Elaboration of the topic
- Speech and layout of the presentation
- Contributions to the discussion
- Completeness of the submitted materials

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The students will be confronted with current research topics in the field of environmental biotechnology and they will acquire and practice skills that are required for the presentation and discussion of scientific problems.
The following subject areas will be covered:
- Biomaterials and Enzyme Technology
- Syngas Technologies
- Environmental Microbiology
- Geobiotechnology & Environmental Chemistry
- Microbial Production Technology & Biorefineries
- Microalgae Biotechnology and related topics

Current topics and supervisors: see e-learning course
For registration follow the instruction on the BOKUlearn site!

Intended Learning Outcomes:
The students have obtained an overview on current scientific topics in the field of environmental biotechnology. They are able to perform a literature research on a given topic and to present the essential items in an oral presentation. Furthermore, they are able to actively participate in a scientific discussion.

Teaching and Learning Methods:
Based on a starting publication provided by the supervisor, the students perform a literature research and elaborate a scientific presentation on a specific topic in the field of environmental biotechnology. The oral presentations (15 min) are held in front of a plenum (participating students and supervisors) followed by a discussion. All students are also obliged to take part in the discussion.

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

CS0108: Catalysis | Catalysis

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
Results will be assessed by a written exam (90min), whereby the students explain important facts of technical catalysis chemistry, mechanistic aspects of catalysts how catalysts work, what is their typical composition and show practical applications by using examples.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic organic and inorganic chemistry

Content:
transition metal compounds, homogenous/heterogenous catalysis, mechanistic details of activation of organic and inorganic molecules at transition metal compounds, surface chemistry, characterisation of catalysts, heat/mass transfer at catalyst grains, reactor designs

Intended Learning Outcomes:
Students can show important chemical aspects of the phenomenon of catalysis with simple examples. They can show the implication of a catalyst in an overall reaction and can quantify it mathematically by using typical measurable values.

Teaching and Learning Methods:
Using lectures, basic principles of catalysts and catalysis will be transmitted.

Media:
Power point presentation, table, oral teaching, discussion

Reading List:
Dirk Steinborn, Grundlagen der metallorganischen Komplexkatalyse, Vieweg und Teubner Verlag, 2. Auflage 2009 (434 Seiten, 41 €).

Responsible for Module:
Riepl, Herbert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Catalysis (Lecture) (Vorlesung, 3 SWS)
Riepl H [L], Riepl H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0108BOK: Development Cooperation in the Water Sector | Development Cooperation in the Water Sector [CS0108BOK]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:**	**Contact Hours:** 30

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

Description of Examination Method:
Exams are in an "open book" approach. Two exam dates will be offered: 18.12.2023, 16:00 - 17:00, in physical presence in HS 01 / MUG1 [HS XXI] (MUG1-EG/01) 12.01.2024, 16:00 - 17:00: This exam will be held online via ZOOM. Log in to the ZOOM meeting via bokuvienna.zoom.us > Sign in > Join a Meeting with the Meeting ID or the Zoom link: https://bokuvienna.zoom.us/j/68343192905?pwd=aW1wK0hicUh4N2ZIc2tVMUs2Y25ndz09 Meeting-ID: 683 4319 2905 Kenncode: 477338 The procedure for this ZOOM exam is explained in BOKUlearn.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
LV "Hydrologie und Wasserwirtschaft I + II" recommended; or equivalent experience
- English language skills

Content:
This course is about the water sector in international development cooperation. Therefore, the lecturer invited ten representatives from various international organisations as guest speakers. Two to three experts will share their first-hand experiences and illustrate their work with extraordinary examples from various countries and thematic fields every afternoon. The course is spread over five afternoons.

The guests:
- Managing Director of HYDROPHIL GmbH
- Task Manager of the African Water Facility at the African Development Bank
- Group Leader of the Water Security Research Group at the International Institute of Applied Systems Analysis (IIASA)

- Technical Officer for Water and Sanitation of the Austrian Development Agency
- Engineering Consultant with the Water & Sanitation Division of the Inter-American Development Bank
- Senior Environmental, Social and Governance Manager of the Austrian Development Bank
- Senior Water Resources Management Specialist in the Water Unit for Europe and Central Asia, The World Bank
- Head of Secretariat of the IAWD – International Association of Water Service Companies in the Danube River Catchment Area
- Head of the Hydro-consulting section in Vienna, AFRY's competence centre for Hydrology and Climate Change
- Member of the global SNV team and individual consultant for HYDROPHIL and the World Bank
- WASH & environmental advisor at the Austrian Red Cross

Each guest speaker will follow a similar approach:

Introduction:
The presenter starts by briefly introducing themselves, their career and the organisation s/he is affiliated with. The students will learn about the diversity of jobs and organisations. Hence, the course aims to show students the wide range of career opportunities they have in the global water sector in development cooperation.

Technical part:
Here, the guest is free to present any topic s/he has been working on related to the water sector in developing countries (or closely associated with it). The course's objective is to cover a broad cross-section from a thematic point of view. Contributions will cover the various sub-sectors, e.g. hydrology, water resources management, infrastructure development in water supply and wastewater, hydropower development, natural hazards, and climate change adaptation and mitigation. The learning content is presented first-hand by senior experts and managers. Challenges of their international activities are discussed.

Intended Learning Outcomes:
This course aims to show students the wide range of career opportunities they have in the international water sector. Challenges in international projects are discussed from a technical and project management perspective.

Teaching and Learning Methods:
interactive lecture

The learning content is presented first-hand by experts with project experience and discussed with the students. Students are expected to participate in the discussions during the course units actively.

Media:

Reading List:
Empfohlene Fachliteratur
The lecturer uploads the presented documents to BOKU-Learn after each course unit.

Responsible for Module:
BOKU Eder Gerald Institut für Hydrologie und Wasserwirtschaft

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

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

Module Description

CS0109: Sustainable Energy Materials | Sustainable Energy Materials [SEM]

From the basics to the application

Version of module description: Gültig ab summerterm 2023

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 learning outcomes will be checked through a written exam (90 minutes) in which the students have to reproduce essential aspects of sustainable energy materials and their applications through examples. In addition, mathematical problems will be given to show that the students are able to quantify simple examples.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of basic electrochemistry/physical chemistry is beneficial, but not required.

Content:
Sustainable energy management is an important issue to minimize environmental impact and climate change. Electrochemical devices such as fuel cells and batteries can help use Renewable In this course, you will learn about the basics of electrochemistry and various important devices used in current and future energy systems, such as fuel cells, batteries, and electrochemical water splitting. The lectures will cover the working principles, components, materials, applications, and future potential of these devices in the energy economy.
Using catalysts in chemical reactions can increase their speed and selectivity, leading to significant energy savings. One section of the course will focus on fuel cell catalysis, and other ideas such as using catalysts in chlorine electrolysis will be introduced to demonstrate how choosing the right counter reaction can result in energy efficiency. The topic of water splitting to obtain hydrogen will be covered later in the course.
We will examine the use of different materials in energy-related devices and how their electronic and ionic properties affect their performance.

Batteries play a crucial role in electromobility by efficiently storing and releasing electrical energy. One part of the course will cover Li-ion batteries, starting with an overview of their fundamentals and the most common cell types. In addition to discussing the characteristics of typical Li-ion electrode materials and electrolytes, the course will show how key performance characteristics such as energy density, power density, and lifespan are influenced by the cell chemistry. The course will also introduce concepts for the next generation of batteries, such as all-solid-state batteries.

Intended Learning Outcomes:
Upon successful completion of this course, students will be able to:
1. Understand and Explain Key Concepts in Electrochemistry:
o Remember and describe the fundamental principles of electrochemistry, including thermodynamics, kinetics, Pourbaix diagrams, and the Butler-Volmer equation.
o Explain the significance of electrochemical processes in energy conversion and storage technologies.
2. Analyze Electrochemical Systems:
o Interpret Pourbaix diagrams to determine the stability of materials in various pH and potential conditions.
o Apply the Butler-Volmer equation to analyze the kinetics of electrochemical reactions in different energy systems.
o Evaluate the thermodynamic feasibility of electrochemical reactions in sustainable energy applications.
3. Comprehend and Apply Battery Fundamentals:
o Understand the working principles of batteries, including charge/discharge processes, energy density, and power density.
o Differentiate between various battery types (e.g., lithium-ion, sodium-ion, solid-state, flow batteries) based on their materials, design, and application potential.
o Apply knowledge of battery chemistry to assess the performance and suitability of different battery types for specific sustainable energy applications.
4. Develop and Evaluate Sustainable Battery Solutions:
o Develop strategies for improving the efficiency, lifespan, and environmental impact of existing battery technologies.
o Critically evaluate the potential of emerging battery materials and technologies for future energy storage solutions.
5. Understand and Analyze Hydrogen Fuel Cells:
o Explain the principles of hydrogen fuel cells, including the role of catalysts, membrane technology, and the overall electrochemical process.
o Analyze the efficiency and challenges associated with hydrogen fuel cells in comparison to other energy conversion technologies.
o Evaluate the environmental and economic implications of hydrogen fuel cell deployment in various sectors.
6. Comprehend and Apply Knowledge of Electrolyzers:
o Understand the operation of electrolyzers, particularly in the context of hydrogen production from renewable energy sources.

7. Integrate Knowledge to Develop Sustainable Energy Solutions:
o Synthesize knowledge from electrochemistry, battery technology, and hydrogen energy systems to propose innovative solutions for sustainable energy storage and conversion.
o Critically evaluate the trade-offs between different energy materials and technologies, considering factors such as cost, scalability, environmental impact, and performance.
These learning outcomes are designed to ensure that students not only grasp the theoretical concepts of sustainable energy materials but also apply and evaluate these concepts in practical, real-world contexts.

Teaching and Learning Methods:
The module consists of a lecture with integrated exercises. The learning content is conveyed through lectures. In the integrated exercises, students work on individual questions and present their solutions.

1) Lectures:
- Purpose: Lectures provide the essential theoretical foundation in sustainable energy materials, covering key topics like basic electrochemistry, battery fundamentals, and hydrogen fuel cells.
- Approach: Interactive and structured with clear explanations, visual aids, and real-world examples, lectures often include brief in-class exercises to reinforce understanding.
- Outcome Alignment: Lectures support learning outcomes related to understanding and explaining core concepts, while integrated exercises help students begin to apply and analyze these ideas.

2) Exercises and Problem-Solving Sessions:
- Purpose: These sessions reinforce lecture material, allowing students to practice problem-solving, apply theory to real-world scenarios, and deepen their understanding.
- Approach: A mix of individual and collaborative exercises, including problem sets, with guidance from instructors to support learning.
- Outcome Alignment: Exercises align with outcomes related to applying, analyzing, and evaluating knowledge, preparing students for advanced tasks in projects and labs.

Media:
1) Presentation Slides:
• Purpose: Presentation slides will be the primary medium for delivering content during lectures. They will be designed to visually complement the spoken content, providing clear and concise explanations of key concepts, diagrams, equations, and real-world examples.
• Usage: Slides will be used to illustrate complex ideas in electrochemistry, battery technology, and hydrogen systems, helping students to follow along and understand the material more effectively. Key points, equations (e.g., Butler-Volmer equation), and visual aids (e.g., Pourbaix diagrams) will be highlighted to enhance comprehension.
• Accessibility: All slides will be made available to students before or after the lectures via the course’s online platform, allowing for review and study at their own pace.
2) Online Learning Platform:

• Purpose: The online learning platform (e.g., Moodle, Blackboard) will serve as the central hub for course materials, communications, and assessments. It will facilitate a blended learning approach, integrating various media forms into a cohesive learning experience.
• Usage: The platform will host lecture slides, videos, reading materials, quizzes, and assignments. It will also be used for discussion forums where students can ask questions and engage in peer learning. This platform supports continuous access to resources and enables students to manage their learning effectively.
• Interactivity: Features such as quizzes, polls, and discussion boards will allow students to interact with the material and with each other, enhancing engagement and reinforcing learning.
3) Textbooks and Research Articles:
• Purpose: Textbooks and scholarly articles provide in-depth coverage of theoretical concepts and the latest research developments in the field. These resources are essential for supporting lecture content and offering additional perspectives on topics covered in the course.
• Usage: Core textbooks will be recommended for fundamental concepts, such as basic electrochemistry and battery technology. Research articles will be assigned to provide insights into recent advancements and emerging trends in sustainable energy materials. These readings will complement lecture content and form the basis for exercises and discussions.
• Depth: By engaging with these texts, students will deepen their understanding of the material and develop critical thinking skills, particularly in evaluating new research and technological developments.

Reading List:
Handbook of fuel cells, Wolf Vielstich, Hubert A. Gasteiger, Arnold Lamm, 2010
Electrochemical Systems, Karen Thomas-Alyea, John E. Newman, 2021

Responsible for Module:
Ledendecker, Marc; 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

CS0109BOK: Practical Course Biobased and Biodegradable Plastics | Praktikum Biobasierte und biologisch abbaubare Kunststoffe

Versio

- Setup, preparation and media preparation for a photobioreactor (airlift-external loop) at laboratory scale
- Inoculum preparation, inoculation, process control, operation of a batch fermentation process, sampling
- Concentration of an intracellular product (centrifugation)
- Analysis and evaluation of the results

Example 2: Heterotrophic production of PHB with a bacterial strain
- Setup, preparation and media preparation, sterilization of a bioreactor
- Inoculum preparation, inoculation, process control, operation of a fed-batch fermentation process, sampling
- Concentration of an intracellular product via microfiltration
- Analysis and evaluation of the results

The practical work and the results will be elaborated and assessed within the group. There will be a presentation day, where results and experiences of each are presented and discussed with all participants.

Intended Learning Outcomes:
The students are familiar with the practical work required for the operation of a biotechnological production process for biobased and biodegradable plastics and have conducted at least partially some of these operations in person.

The students are able to relate the theoretical knowledge from lectures with practical experiences and may also have experienced that practical processes can deviate from theoretically expected behavior.

The students have the ability to elaborate their own results and present them to a larger audience. They have sufficient insight on the topic to spontaneously engage in a discussion and to answer detailed questions related to their practical work and results.

Teaching and Learning Methods:
- Basic theoretical principles from the course 970304 or self-study from the provided course material

- Performing practical experiments and analyses in the laboratory or pilot plant under supervision. Practical work ranges over a period of approx. 3 weeks. With the exception of certain days (inoculation, harvest, etc.) permanent presence is not required. A working schedule will be prepared within the group. Total presence for the practical work will be approx. 40 hours.

- Elaboration of the results as teamwork. Presentation of the conducted work and the results; the groups present their work to each other. Presentations will be discussed in a plenary session. Each participant is obliged to participate in the discussion and to ask and answer questions.

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

CS0110BOK: Harvesting Systems for Mountainous Regions | Harvesting Systems for Mountainous Regions [CS0110BOK]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 0	**Contact Hours:** 60

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

Description of Examination Method:
Written
Online via Moodle

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
• General conditions of harvesting systems in Austria
• Harvesting processes, operating techniques and systems
• Equipment and machines
• Damages to stock and soil
• Personal protective equipment
• Cutting and limbing methods using chain saw
• Accident prevention
• Cable yarding systems
• ÖNORM L5219
• Cable mechanics
• Ergonomics
• Concepts of stress and strain
• Noise, vibrations, work intensity, fumes, long-time loading barrier
• Expense budgeting (machines, harvesting method), cost category
• Productivity

Intended Learning Outcomes:
• Understanding and analyzing the dimensions within mountain forest harvesting systems
• Evaluate economic, ecologic and human dimensions of harvesting methods
• Understanding and applying important aspects of occupational health and safety

Teaching and Learning Methods:
mit medialer Unterstützung

Media:

Reading List:

Responsible for Module:
BOKU Stampfer Karl und Holzleitner Franz Institut für Forsttechnik

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

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

Module Description

CS0111: Advanced Development Economics | Advanced Development Economics

Version of module description: Gültig ab winterterm 2023/24

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 will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Micro- and Macroeconomics

Content:
Why are some countries developing and some are trapped in poverty? What are the determinants of economic growth? What is the role of demography, institutions (in particular the state), the environment, labor, migration, capital or credit markets in the development of states? What is the importance of development aid & cooperation? These are some of the questions that decision-makers in the developed and developing countries have to discuss every day. This course provides a theoretical foundation and empirical evidence for the analysis of the most important questions of today's development of the world.

Intended Learning Outcomes:
After visiting the module, the students can use the development economy to understand what is hindering development and what factors lead to success. They can apply theories, concepts, and analytical techniques associated with macroeconomics. Students learn to understand the difference between growth and development, the reasons and impact of migration, the role of institutions (e.g. properte and use rights), development cooperation and international trade. The

students are able to analyze empirical evidence on economic development and to critically read the literature in the field of economic development.

Teaching and Learning Methods:
The lecture and the exercise will be done by PowerPoint. In addition, current examples from newspapers and journals will be integrated into the lectures. In the exercise, the students research current case studies linked to the theories and concepts presented in the lecture. These case studies are then individually and / or groupwise discussed and questioned from different perspectives together with the students. Web lectures by internationally renowned experts and researchers will be integrated into the lecture.

Media:
Presentations, slide scripts, Articles, online lecture examples

Reading List:
Alain de Janvry, Elisabeth Sadoulet (2016). Development Economics - Theory and Practice. Routledge; Michael Todaro, Stephen Smith (2012). Economic Development, Pearson.

Responsible for Module:
Faße, Anja; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Development Economics (Lecture) (Vorlesung, 2 SWS)
Faße A [L], Faße A

Advanced Development Economics (Tutorial) (Übung, 2 SWS)
Faße A [L], Faße A, Shayo G
For further information in this module, please click campus.tum.de or here.

Module Description

CS0111BOK: Human Impacts in Riverine Landscapes | Human Impacts in Riverine Landscapes [CS0111BOK]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	Language: English	Duration: one semester	Frequency: winter/summer semester
Credits:* 2	**Total Hours:** 45	**Self-study Hours:**	**Contact Hours:** 45

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

Description of Examination Method:
Written test, 8 questions need to be answered and argued (no multiple choice test)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in hydrobiology & fish ecology

Content:
Current problems in applied fish ecology

- Discussion of impact models (e.g. drivers and pressures - DPSIR, cascade models)
- Overview of the status quo of running waters (global, EU/Alps, Austria)
- Overview of major human pressures/related impacts
- Discussion of different types of human impacts
- Discussion of case studies

TOPICS OF LECTURES

#1 - Introduction

#2 - Impacts due to hydro-power production (Hydro-power use: run-of-river-/diversion-/storage power plants; connectivity/fragmentation)

#3 - Impoundments & reservoir flushing (flow patterns, sediment transport etc.)

#4 - Residual flow/water abstraction (minimum flow requirements)

#5 - Hydropeaking (magnitude, frequency, duration, effects on hydro-morphology)

#6 - Morphological impacts (effects on physical environment, riverine habitats, floodplains, vegetation/land-use etc.)

#7 - Pollution (organic pollution, toxic substances etc.)

#8 - Land use change (forms of land use, nutrients etc.)

#9 - Multiple impacts (interactions of pressures etc.)

Intended Learning Outcomes:
1. Get an overview of fish-ecological conditions in Austrian & European rivers.
2. Evaluate the impacts of human activities on running waters.
3. Lern and discuss methods for assessing and improving ecological integrity.

Teaching and Learning Methods:
9 lectures -> exam based on these contents

Media:

Reading List:

Responsible for Module:
BOKU Schmutz Stefan, Greimel Franz, Hayes Daniel S. Institut für Hydrobiologie und Gewässermanagement

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

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

Module Description

CS0112: Advanced Seminar in Supply and Value Chain Management | Advanced Seminar in Supply and Value Chain Management

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**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 seminar paper, implemented optimization or simulation models as well as an oral presentation & discussion. The seminar paper should cover 15-20 pages and is written in the style of current publications of peer-reviewed journal articles. Accompanied with the seminar paper models have to be implemented to conduct numerical analyses, which will be handed in as a digital appendix. At the end of the module students present their work in a 45 minutes presentation. Weighting: 1:1

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Recommended: One module in the field of Supply Chain Management

Content:
The advanced seminar focuses on recent research progress on varying topics in service operations, e.g. omni-channel retailing, online retail management. Students identify strategic and operational relationships between supply chain management, marketing and service functions. Thereby, empirical research methods (such as regression models) are applied as well as mathematical optimization and simulation models (such as mixed-integer programming or discrete event simulation) to identify best practice relationships. Several topics with applications in assortment planning, last mile logistics, transportation, inventory management and procurement are available.

Intended Learning Outcomes:
The objective of the module is to equip the participants with the necessary skill and tools for a successful master thesis project.

Specifically, the aim is to be able to:

- Read and understand recent research contributions
- Pursue interesting research questions
- Conduct a literature study and/or numerical study and/or implementation
- Structure and organize research methods and results
- Write a seminar paper
- Present research findings and defend them in a discussion

Teaching and Learning Methods:
In an introductory session, the current theme of the module is explained by the lecturer and the various available seminar topics are elaborated in detail. Also information on relevant literature for the problem settings is introduced, wich forms the basis of the students' seminar papers. After the introductory session, students will work out the topic on their own, by using their abbilities of conducting literature research, mathematical modelling, programming and analyses. Throughout the whole time, they receive guidance from a supervisor of the chair. Different milestones are to be achieved at specific dates, such as a preliminary outline of the seminar paper, first research results and the final paper. Following the submission of the final paper, presentations and discussions of all students' seminar papers are conducted, usually spanning one or several days, where amongst others also presentation, moderation and discussion skills are trained.

Media:
Research paper; presentation slides

Reading List:

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar in Supply and Value Chain Management (Seminar, 4 SWS)
Hübner A [L], Hübner A, Riesenegger L, Tuma N
For further information in this module, please click campus.tum.de or here.

Module Description

CS0112BOK: Lecture Series in Soil, Water and Atmosphere | Lecture Series in Soil, Water and Atmosphere [CS0112BOK]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:**	**Duration:** one semester	**Frequency:** one-time
Credits:* 3	**Total Hours:** 60	**Self-study Hours:**	**Contact Hours:** 60

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

Description of Examination Method:
written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
This course introduces students to the science and practice of hydrology and water management. More specifically, it aims at understanding hydrological processes; physical, chemical and biological processes in soil and water; and soil-plant-water-atmosphere relations.
One focus is on the introduction of methods and techniques regarding monitoring and modelling of hydrological processes. The requirements of environmental, spatial data (e.g. precipitation, land cover, soil type, etc.) are emphasized and public access data sources are referenced. Examples of applications of hydrological models for flood forecasting and groundwater resources management are addressed. Hydrological processes are then considered in terms of sustainable management of water and soil. Another focus is on urban water management.
Topics include water balance components, soil properties, water retention and water fluxes, crop water requirements, water quality, drinking water supply, and wastewater treatment.

Intended Learning Outcomes:
After successful completion of this course, students will be able to
- name and describe the physical and hydraulic properties of soils and the respective methods of soil analysis

- explain the processes controlling the storage and transport of water within the unsaturated and saturated zone and river channels
- explain the FAO-approach for determining crop water requirements and irrigation demand
- argue the need for process monitoring with respect to model development and prospective planning
- identify the dominant hydrological processes for runoff formation
- find and apply public access data bases of environmental data sets

Teaching and Learning Methods:
interactive lecture

Media:

Reading List:

Responsible for Module:
BOKU Ertl Thomas, Holzmann Hubert, Nolz Reinhard Institut für Bodenphysik und landeskulturelle Wasserwirtschaft

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

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

Module Description

CS0113: Innovation in Bioeconomy | Innovation in Bioeconomy

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/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 grading is based on a written exam (90 Minutes). The written form of the exam allows a comprehensive assessment of students' knowledge and understanding of the principles of innovation management and entrepreneurship with a focus on bioeconomic questions and concepts. Building on a core understanding of the principles of innovation management and entrepreneurship, students will answer questions about the more recent innovation and entrepreneurship concepts and have the ability to explain the adapted strategies and options for new ventures firms. They will also be able to assess the relevance of technologies and resources related to the bioeconomy and the different options to design sustainable business models in the context of bioeconomic questions.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Entrepreneurship, Introduction to Innovation Management

Content:
The module introduces students into advanced principles of innovation management and entrepreneurship from a sustainable perspective. Students will be equiped with basic knowledge on:
- design of business models to implement sustainable innovation
- advanced methods to generate and implement sustainable innovation
- role of ecosystems and networks

Beyond that, students will engage in break-out group workshops to personally experience the process of developing and evaluating sustainable innovation activities. Students give presentations to the audience and discuss their results.

Intended Learning Outcomes:
Following the completion of the course, the students will be familiarized with theoretical concepts and empirical methods to:
• assess the different forms and contents for identifiying and organising entrepreneurial ideas and innovative solutions in the context of the Bioeconomy by including broader economic, environmental and societal effects
• derive recommendations about the design and practices of innovation management and entrepreneurship and how to implement sustainable innovation
• identify and evaluate environmental technologies and design scenarios for firms to implement sustainable innovation

Teaching and Learning Methods:
The module will combine several learning methods.
- The basic knowledge as well as real world examples and case studies will be provided through the lecture.
- Discussions in the lecture and active participation are encouraged and will contribute to deepen the understanding of the concepts introduced.
- In the tutorial, the academic concepts will be discussed and applied in case studies. The students will further apply (part of) their theoretical knowledge to real-world problems and present their results in teams. This format fosters team work.
- Students will get additional background knowledge from the scientific literature in private reading.

Media:
Presentation, Power-Point Slides, Case Studies

Reading List:
The reading list is compiled from the latest contributions of relevant scientific journals, including the Academy of Management Journal, Research Policy, Strategic Management Journal, and will be made available to the students.

Responsible for Module:
Doblinger, Claudia; Prof. Dr. rer. pol. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Innovation in Bioeconomy (Lecture) (Vorlesung, 2 SWS)
Doblinger C [L], Doblinger C

Innovation in Bioeconomy (Exercise) (Übung, 2 SWS)
Doblinger C [L], Doblinger C, Fischer D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0113BOK: Molecular Evolution and Phylogenetics | Molecular Evolution and Phylogenetics [CS0113BOK]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:**	**Contact Hours:** 30

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

Description of Examination Method:
Written exam

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The advancement of sequencing technologies has resulted in the generation of sequencing data at a scale without precedence. Importantly, such data cannot just enlighten us about the biology of individual species, but can also be used to infer phylogeny, to assess evolutionary trends, and to study the changes within genomes over time. The lecture will provide insight into the molecular principles underlying the evolution of DNA, proteins and genomes. Different ways how to perform phylogenetic analyses will be discussed. Bioinformatics methods to study molecular evolution will be presented.

Intended Learning Outcomes:
The students will obtain an overview of the molecular concepts underlying evolution, and will obtain knowledge on how bioinformatics can be used to perform phylogenetic analyses and evolutionary studies.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
BOKU Himmelbauer Heinz Department für Biotechnologie

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

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

Module Description

CS0114: International Trade | International Trade

Version of module description: Gültig ab winterterm 2023/24

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 will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Micro- and Macroeconomics

Content:
Basics of trade theory, such as Gains of Trade are deepened. Effects of customs duties and non-tariff trade barriers, such as environmental standards are presented. It deals with the concept of Pollution Haven and Race to the Bottom. The World Trade Organization and its role in international trade will be presented and discussed on the basis of current trade agreements and conflicts.
In addition, the lecture gives an overview of the effects of trade on international resources consumption. In doing so, empirical trade models (e.g., Gravity Model) are used for clarification.

Intended Learning Outcomes:
Students develop an understanding of theories and empirical methods used in the analysis of international trade. They know how trade policy affects the competitiveness and well-being of society and can apply these methods to the core issues of the globalization debate and sustainable trade.

Teaching and Learning Methods:
The lecture and the seminar will be done by PowerPoint. In addition, current examples of trade policy from the media and journals will be integrated into the lectures. In the seminar, the students research current case studies on the theories and concepts presented in the lecture. These case studies are then individually and / or groupwise discussed and questioned from different perspectives together with the students. Empirical trade models are used and discussed.

Media:
Presentations, slide scripts, Articles

Reading List:
Krugman, Obstfeld (2016) International Economics: Theory and Policy, Global Edition; Michael Todaro, Stephen Smith (2012). Economic Development, Pearson.

Responsible for Module:
Prof. Dr. Anja Faße

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

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

Module Description

CS0

Crop conservation with silage making (principles and processes)

Storage of crops (potato, fruit, vegetable,?); Principles and applications

Special post-harvest technologies in horticulture and viticulture

Intended Learning Outcomes:
Understanding of biological and physical properties of harvested crops and their comprehension

Qualification for systematic analyses of post harvest technology

Qualification for planning of post harvest technology

Evaluation of post-harvest technologies on engineering fundamentals as well as ecological and economic aspects.

Teaching and Learning Methods:
interactive lecture

Media:

Reading List:

Responsible for Module:
BOKU Pejakovic Vladimir, Gronauer Andreas Institut für Landtechnik

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

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

Module Description

CS0115: Master's Thesis | Master's Thesis

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 850	**Contact Hours:** 50

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

Description of Examination Method:
The module examination consists of the preparation and positive evaluation of the Master's Thesis (approximately 25 to 100 pages, depending on the topic). The overall grade is determined by the grade of the Master's Thesis.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
70 credits including all compulsory modules of the Master's program

Content:
Deepening the knowledge of current academic literature on a specific topic, which can be freely chosen from the program in consultation with the supervisor. Deepening the knowledge of appropriate research methods, as well as gaining experience in their application.

Intended Learning Outcomes:
After completing the module, students are able to derive complex scientific questions and to work on them independently using adequate scientific methods. In doing so, they demonstrate their ability to think analytically on their own. They are able to present their results conclusively, discuss them, and draw final conclusions.

Teaching and Learning Methods:
First, together with the supervisor, the topic is
the topic is narrowed down and a research question is developed. Within the framework of the Master's Thesis, the students work on this scientific question. Among other things, literature research, theoretical models and/or empirical methods are applied. The actual teaching and

learning methods depend on the respective research question and are decided jointly with the supervisor in each individual case.

Media:
Academic literature, software, etc.

Reading List:
in consultation with the supervisor

Responsible for Module:
Alle prüfungsberechtigten Dozenten/innen des Studienganges

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

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

Module Description

CS0115BOK: Organisational Behaviour | Organisational Behaviour [CS0115BOK]

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor/Master	Language: English	Duration: one semester	Frequency: winter semester
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:
Written
A min. of 50% of points is necessary to complete the course.

Repeat Examination:

(Recommended) Prerequisites:
Some knowledge about general processes in organisations is desirable (e.g. based on your work experience, including summer jobs).

Content:
Organizational behaviour is a field of research that seeks to understand and explain human behaviour in the workplace. This addresses individual behaviour with topics such as work motivation and job satisfaction; dynamics within groups; as well as the influence of organisational structure and the use of technology on the behaviour of people. The aim is to manage people more effectively and to enhance the quality of employee's work life. Understanding the human side of management will be helpful in your career, as you will depend on people to accomplish tasks and projects: you will need to work for other people, work with other people, and supervise other people. The course offers you the opportunity to apply concepts to real-world problems such as resolving conflicts and overcoming resistance to change, which will allow you to develop your leadership potential.

The course is designed as 'team-based learning'. Students will be assigned to a team for the duration of the course. Course material will be mainly acquired through independent reading of the text book. During classes, the focus will be on case studies and role plays. Through its focus on work within the teams, it gives you an opportunity to better understand your own as well as other's behaviour.

The course is offered in time-compressed mode, i.e. there will be 5 classes with 5 hours each. You can choose between the course offered on Tuesday (in-class, thus focusing on face-to-face interactions), or the one offered on Saturday morning (online, thus focusing on virtual team work and digital competencies). For further information a detailed Syllabus will be available in late September.
Important: attendance in the first class is compulsory.

Intended Learning Outcomes:
Upon completion of the course, students are able to:
+) explain organisational theory as it relates to the design of organisations, teamwork, leadership, management practices, work motivation, and job satisfaction
+) evaluate the benefits and challenges of alternatives, and thus make sound recommendations to improve the performance at individual and team level
+) communicate their understanding of a problem clearly and non-judgementally, thus contributing to its resolution within a team
+) analyse team dynamics and structure team work so as to foster cooperation and synergies between team members, not least by providing constructive feedback to team members
+) recognize their own strengths and preferences (e.g. regarding leadership style, preferred organisational culture, work organisation)

Teaching and Learning Methods:
Vorlesung mit integrierten Übungen

Team-based Learning: students need to read chapters of the book before class. During class there are brief lecture providing theoretical input, and most of the time is devoted to group work (case studies and role plays). The groups reflect on the experiences during the group work and the insights are discussed in the plenary.

Media:

Reading List:

Responsible for Module:
BOKU Darnhofer, Ika Institut für Agrar- und Forstökonomie (AFO)

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

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

Module Description

CS0116BOK: Game Theory in Environmental and Natural Resource Management | Game Theory in Environmental and Natural Resource Management [CS0116BOK]

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
Written Exam

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
This course offers an introduction to Game Theory with examples in Environmental and Natural Resource Management. Game Theory is the mathematical study of strategic interaction among independent self-interested agents.
Game theoretic concepts are applied in disciplines as diverse as economics (e.g., competing firms), political science (e.g., political candidates competing for votes), and biology (e.g., animals fighting over prey) – among others. In environmental and natural resource management, Game Theory is a helpful tool to analyze e.g., international environmental problems, situations when international environmental treaties are decided, or competition over exhaustible natural resources. Prominent games which are utilized to gain insights into international environmental problems are e.g., the Prisoners' dilemma, or the so-called Chicken Game.
Students attending this course will be introduced to formal game theoretic concepts and its practical applications. The lecture will roughly follow this outline:
1. Introduction:
- What is game theory about?
- Basic concepts: Theory of rational choice; representation of games: normal form representation, extensive form representation; Information sets; Strategies (pure and mixed strategies)

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Module Description

CS0117: Consumer Studies | Consumer Studies

Version of module description: Gültig ab summerterm 2024

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 examination will be given in the form of a written examination as well as students' presentations. The students should be able to evaluate and use the methods of consumer and market research that were thought in the module. No additional tools are allowed during written examination. Duration of written examination: 60 minutes. The proportion of the written examination is 50% of the total grade.
The students' presentations aim to present the scientific methods and results of a student project elaborated during the semester. The students present individually or in groups the elaborated results and discuss them with their colleagues and lecturer. Powerpoint and presentation equipment are allowed for the presentations. Students must give an intermediate presentation (duration: 10 minutes) and a final presentation (duration: 20 minutes). Students will only be admitted to the final presentation if they have successfully completed the interim presentation The proportion of the presentations is 50% of the total grade.
Both parts of the grade (written examination and presentation) must be passed in order to successfully complete the module.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in statistics

Content:
The content of the module comprises of theory and analysis tools related to consumer behavior as well as their practical implementation. After a general introduction into the theory of consumer behavior the following topics will be covered in the module: consumption models, attitudes, involvement, knowledge, motives, lifestyles and other psychographic constructs. Additionally the students will become familiar with qualitative and quantitative market research methods. Different

survey tools will be introduced for practical implementation. The same is true for statistical data analysis packages (like e.g. SPSS, R) or qualitative analysis tools.
Additionally, the students use the learnt methods and tools to answer selected questions related to consumer behavior in biobased products or products based on regenerative resources.

Intended Learning Outcomes:
After attending the module, students will be familiar with the determinants of consumer behavior. They are able to understand and use different methods of market and consumer research. They are able to select and execute various methods of data collection (e.g. surveys, observational methods), to statistically analyse the collected data or use qualitative analysis tools, and interprete the results of the analysis. In addition, students can use the theoretical knowledge that is taught in the module to elaborate and implement own solutions to actual questions in the area of consumer behavior.

Teaching and Learning Methods:
The lecture will be done using Powerpoint and and statistic programs to data analysis. In addition, scientifically published studies will be integrated into the lectures. In the students' project, students use the theoretical knowledge and learnt methods of consumer and market research to analyse specific scientific questions related to consumer behavior. Finally, students will present and discuss their approach and results with their collegagues and lecturers.

Media:
Presentations, slide scripts

Reading List:
Mayring, P. (2014): Qualitative content analysis: theoretical foundation, basic procedures and software solution.
Klagenfurt. https://nbn-resolving.org/urn:nbn:de:0168-ssoar-395173
Backhaus, K.; Erichson, B.; Gensler, S. Weiber, R., Weiber, (2021): Multivariate Analysis – An Application-Oriented Introduction Berlin, Springer
Hoffmann, S.; Akbar, P. (2023): Consumer Behavior. Berlin, Springer

Responsible for Module:
Decker, Thomas; 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

CS0117BOK: Adhesive Technology | Adhesive Technology [CS0117BOK]

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:**	**Contact Hours:** 60

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

Description of Examination Method:
oral & immanent exam character (lab part) Due to the immanent exam character of this lecture (VU) a positiv exam is to be reached until February 15th of the following semester. Positive lab activities cannot be transfered to follow up semesters.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
This course and the practical exercises concentrate on the application oriented evaluation of the various adhesives in use in the woodworking industry:

Content of the course:

· Types, chemical basic and production of various adhesives

· properties of adhesives (in combination with practical exercises)

· application of adhesives, hardening and setting behaviour, forming of bonding strength

· basics of gluing and bonding

· possible problems in gluing and bonding

· modification of wood

· activation of the wood surface, binderless gluing

· ecological topics (effluents, waste, emissions)

· application and use of adhesives (in combination with practical exercises) .

Intended Learning Outcomes:
The students will learn in this course about various adhesives with different chemical composition and their production, properties and application. Reaching the aim of the course the student will have enough basic knowledge on adhesives in the woodworking industry to use in proper way adhesives as well as to evaluate and understand additional informations from various sources.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
BOKU Konnerth Johannes, Logar Lucia, Van Herwijnen Hendrikus Institut für Holztechnologie und Nachwachsende Rohstoffe

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

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

Module Description

CS0118: Environmental Accounting in Economics and Sustainability Sciences | Environmental Accounting in Economics and Sustainability Sciences

Version of module description: Gültig ab winterterm 2023/24

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 will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental accounting in economics. Example problems will have to be explained, solved and discussed. Type of examination: written, no additional tools allowed, duration of examination: 90 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Micro- and Macroeconomics, Advanced Sustainability and Life Cycle Assessment

Content:
Fundamentals of the national accounts (input-output analysis) and the extension to environmental and social accounts (NAMEA, Social Accounting matrix). Integration of environmental accounts through physical and monetary environmental accounts and their advantages and disadvantages. Execution of multiplier analyzes with Excel. Use of input-output analysis and its environmental extensions for material flow analysis. Dynamic and multi-regional input-output approaches and hybrid Life Cycle Assessment.

Intended Learning Outcomes:
After the module, students will be able to understand and develop the system of national accounts and the integration of environmental accounts (monetary and physical) at national and regional level. They are able to perform and interpret a multiplier analysis. They use advanced methods of input-output analysis to solve problems in material flow analysis.

Teaching and Learning Methods:
The lecture and the tutorial will be done by Powerpoint and Excel. In addition, current examples from scientific journals and data sets will be integrated into the lectures. For advanced examples the use of a mathematical software suite such as Matlab and input-output as well as life cycle inventory databases is intended. These case studies are then analyzed and discussed individually and / or in groups from different perspectives together by the students.

Media:
Presentations, slide scripts, Articles

Reading List:
Taylor (2008): Village Economies: The Design, Estimation, and Use of Villagewide Economic Models. Cambridge University Press; Anguita & Wagner (2010): Environmental Social Accounting Matrices: Theory and Applications, Routledge. Brunner/Rechberger (2017): Handbook of Material Flow Analysis, CRC Press; Miller/Blair (2009): Input-output Analysis: foundations and extensions, Cambridge University Press; and recent journal articles (to be announced in the lectures)

Responsible for Module:
Anja Faße

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

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

Module Description

CS0118BOK: Protein Chemistry and Protein Engineering | Protein Chemistry and Protein Engineering [CS0118BOK]

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4	**Total Hours:** 90	**Self-study Hours:** 30	**Contact Hours:** 60

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

Description of Examination Method:
Successfull participation in practical part and written exam about the theoretical lecture part.
Written exam: 6 questions with 5 points each sehr gut (very good, 1): 28-30 points gut (good, 2): 25-27 points befriedigend (3): 20-24 points genügend (4): 16-19 points nicht genügend (negative, 5): 0-15 points

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic lectures in Organic Chemistry, Biochemistry and Molecular Biology

Compulsory course for Master students in Biotechnology with focus on Bioprocess Engineering and Medicinal Biotechnology. Optional course for other master programmes.

Content:
THEORETICAL PART - LECTURES
The theoretical parts might not be presented in this order!

Unit 1: Historical perspective, Therapeutic use of antibodies, Evolution in nature and in the lab: ZAJC

Unit 2: Forces between molecules, Protein structures: ZAJC

Unit 3: Thermodynamics of protein folding and unfolding:
ZAJC

Unit 4: Real-world examples for recent advances in protein engineering: ZAJC

Unit 5: Mutagenesis strategies I: PETERBAUER

Unit 6: Mutagenesis strategies II: PETERBAUER

Unit 7: Protein libraries: WOZNIAK-KNOPP

Unit 8: Surface Display: WOZNIAK-KNOPP

Unit 9: Protein dynamics and molecular dynamics simulations: OOSTENBRINK

Unit 10: Functional studies on proteins I: Enzyme kinetics (steady-state versus presteady kinetics): FURTMÜLLER

Unit 11: Functional studies on proteins II: Ligand binding and protein-protein interaction (surface plasmon resonance, biolayer interferometry ect.): FURTMÜLLER

PRACTICAL PART:

Databases and phylogeny: LUDWIG

Protein structure modeling and prediction: OOSTENBRINK

Intended Learning Outcomes:
After completing this course and passing the exam students should understand the relationship between protein structure and function as well as protein dynamics and stability. Moreover they will have an overview about the most important techniques in elucidation of protein structure and quality. The principles in protein design and engineering will be discussed as well as the use of the most important databases, elucidation of protein phylogeny. Further, students will gain insight into the basics in protein modeling and structure prediction

Teaching and Learning Methods:
Theoretical lectures combined with practical courses

Media:

Reading List:

Responsible for Module:
BOKU Furtmüller Paul Georg, Ludwig Roland, Oostenbrink Chris, Peterbauer Clemens Karl, Wozniak-Knopp Gordana, Zajc Charlotte Institut für Biochemie

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

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

Module Description

CS0119: Behavioral Public Economics | Behavioral Public Economics

Version of module description: Gültig ab winterterm 2023/24

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 will be given in the form of a written examination. The students should be able to describe theories, methods and concepts of Behavioral Public Economics. Students should be able to explain important examples from the academic literature. Type of examination: written, calculators are allowed, no additional tools allowed, duration of examination: 90 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Microeconomics, Advanced Microeconomics

Content:
In this course combines public economics with recent contributions of behavioral economics. Students will learn how to apply findings from behavioral economics to the public sector. This course will combine standard models from text books with recent academic papers. We will cover classic theories, their behavioral extensions, and empirical studies. Cover topics will be:
- Welfare Analysis
- Taxation
- Public Goods / Externalities
- Political Economy (Politicians and Voting)
- Public Policy (Savings, Poverty, Health, Environment)

Intended Learning Outcomes:
After attending the module, students will understand current topics in Public Economics and know the relevant insight from behavioral economics. They are capable of applying economic theory to analyze current problems and they can reference the relevant empirical evidence. Students can

analyze and evaluate policy proposals. Based on existing examples they can design and discuss their own policy interventions.

Teaching and Learning Methods:
The lecture will be mostly done by presentations. In addition, articles from newspapers and journals are integrated into the lectures. Together with the lecturer, students will study the content and methods of the academic papers. In the exercises, students will practice solving the learned models. This will either be done jointly on the blackboard or as work in smaller groups. Classroom experiments are carried out for selected topics.

Media:
Presentations, slide scripts, Articles, online lecture examples

Reading List:
Atkinson, A. and Stiglitz, J. (1980), Lectures on Public Economics, McGraw-Hill; reprinted by Princeton University Press (2015).
Gruber, J. (2016) Public Finance and Public Policy, 5th edition, Worth Publishers.
Additional references of academic papers

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Behavioral Public Economics (Exercise) (Übung, 2 SWS)
Goerg S [L], Goerg S

Behavioral Public Economicpnon

Module Description

CS0119BOK: Energy Technology Fundamentals | Grundlagen der Energietechnik [CS0119BOK]

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
Written
ONLINE exam, Multiple Choice test, see Online information/Additional information and BOKU learn for details

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge of basic physics recommended.

Content:
Importance of energy for mankind
Mechanical and electrical energy and energy technology
Thermal energy and fundamentals of thermodynamics
Thermodynamic cycles, exergy and anergy
Practical thermodynamic cycles
Chemical energy technology
Electrochemical energy technology

Intended Learning Outcomes:
The students of this course...

... know the relevant forms of energy.
... are competent to work with energy and power units.
... know the definition and significance of thermodynamically relevant quantities of state (enthalpy and entropy).

... know the fundamental limitations for the conversion of energy to other energy forms.
... are able to apply the fundamental physical-thermodynamic principles to energy conversion chains and can, on this basis, determine efficiency figures for energy conversion processes.
... know the state-of-the-art technologies for the conversion of primary energy to final energy.

Teaching and Learning Methods:
multimedia-supported

Interactive online corse with pre-recorded video streams of the lecture and interactive video conferences for questions&answers and further discussion.

Media:

Reading List:

Responsible for Module:
BOKU Pröll Tobias Institut für Verfahrens- und Energietechnik

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

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

Module Description

CS0120: Advanced Sustainability and Life Cycle Assessment | Advanced Sustainability and Life Cycle Assessment

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:
Written exam (90 minutes): Students have to solve problems from the thematic field of the module. They have to prove their ability to use the right vocabulary, apply their knowledge on advanced topics in life cycle and systems thinking, sustainability and and life cycle assessment. Learning aids: pocket calculator.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamental knowledge in Life Cycle Assessment as demonstrated e.g. by the successful participation of the module Material Flow Analysis and Life Cycle Assessment or Principles of LCA.

Content:
The module contains units covering the following topics:
• Systems and life cycle thinking
• LCA following the ISO 14040/14044 and ILCD standards
• Extension of Life Cycle Assessment to Life Cycle Sustainability Assessments
• Advanced Life Cycle Impact Assessment Methods such as for
- Land use and land use change
- Water use
- Resource use
• Attributional and consequential assessments
• Regionalisation of inventories and impact assessments
• Hybrid approaches
• Uncertainty handling

• Interface with Multi Criteria Decision Analysis
• Presentation and visualisation of results
• Handling of data uncertainty
• Current trends and developments
• Software systems and data bases for material flow analysis and life cycle assessment
• Case studies

Intended Learning Outcomes:
The students use advanced concepts and tools of sustainability and life cycle assessment to assess products, services and processesregarding their environmental impacts. Thus, they are able to gain a deeper understanding of their underlying material and energy flows and how they impact the environment. With these competencies development and improvement of systems, products and services can be supported, decision support delivered and communication with stakeholders aided.

Teaching and Learning Methods:
Format: lecture and (computer-based) exercises to introduce the content, to repeat and deepen the understanding as well as practice individually and in groups.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individual assignments and presentation
- Computer lab exercises using LCA software systems and Life Cycle Inventory Data bases.

Media:
Digital projector, board, flipchart, online contents, case studies, computer lab

Reading List:
Recommended reading:
• Curran, M.A. (2015): Life Cycle Assessment Student Handbook, Scrivener Publishing:
• Hauschild, M.Z. & Huijbregts, M.A.J. (2015): Life Cycle Impact Assessment (LCA Compendium - The Complete World of Life Cycle Assessment), Springer.
• Klöpffer, W. & Grahl, B. (2014): Life Cycle Assessment (LCA), Wiley-VCH.
• Recent articles from esp. International Journal of Life Cycle Assessment, Journal of Cleaner Production, Journal of Industrial Ecology, Environmental Science and Technology (to be announced in the lecture)

Responsible for Module:
Fröhling, Magnus; Prof. Dr. rer. pol.

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

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

Module Description

CS0120BOK: Laboratory Diagnosis | Labordiagnostik [CS0120BOK]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 60	**Self-study Hours:**	**Contact Hours:** 60

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

Description of Examination Method:
assessment of active participation and a final protocol

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no practical experience necessary

Content:
Short overview of the protein extraction from plant tissue and protein detection using specific antibodies: ELISA immunoassay to detect plant viruses in plant tissues.
Short overview of the extraction of RNA from plant tissue and virus RNA detection using RT-PCR-based method.
DNA fingerprinting of different strains of phytopathogenic fungi.: PCR and digestion of the PCR product with restriction enzymes. DNA detection via gel electrophoresis.

In addition to the experiments that will be conducted by the students basic background information will be given concerning the different detection methods.

Intended Learning Outcomes:
Basic knowledge of antibody-based ELISA test as a tool to detect plant pathogens.
Basic knowledge of PCR-based detection of plant pathogens.
Students can perform ELISA test and PCR to detect plant pathogens.

Teaching and Learning Methods:
laboratory

Media:

Reading List:

Responsible for Module:
BOKU Wieczorek Krzysztof, Gasser Katharina, Hage-Ahmed Karin Institut für Pflanzenschutz

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

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

Module Description

CS0121: Sustainable Production | Sustainable Production [SP]

Version of module description: Gültig ab winterterm 2020/21

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:
Written exam (90 minutes): By solving problems from the thematic field of the module students have to prove their understanding of the management of industrial production processes and technologies under consideration of sustainability aspects. In doing so they have to prove their techno-economic understanding, knowledge on quantitative methods for the analysis, assessment and optimisation of production systems, as well as their analytical and verbal skills in the field. They need to show that they are able to discuss the treated approaches and to derive further research needs. Learning aids: pocket calculator.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

Content:
The module covers inter alia the following topics:
• Sustainability aspects of industrial production and consumption
• Reasons for considering sustainability aspects in production management
• Measuring sustainability of production and operations
• Sustainable product and service design
• Sustainable sourcing
• Sustainable production management
• Sustainability of logistics
• Managing wastes, waste water, air emissions and product returns

Intended Learning Outcomes:
The module aims at enabling students to approach management tasks of production systems under consideration of sustainability aspects. This covers especially , especially the analysis, assessment and optimisation of these using a quantitative systems analysis approach.

The students understand that production and consumption activities have sustainability impacts and why these have to be considered in the management of production systems. They apply quantitative approaches for the analysis, assessment and optimisation of these systems on example planning tasks. They are capable to discuss the approaches critically, derive further development needs and transfer these approaches to other fields.

Teaching and Learning Methods:
Format: Lecture with exercise to introduce, train and deepen the contents of the module.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individual assignments and presentation

The teaching and learning methods are combinded specifically for the treated topics. Typically, a thematic impulse or overview is given with a media-assisted presentation. Individual or group work assignments provide the possibility to apply the acquired competencies, to repeat and deepen these as well as to prepare the transfer to other fields.

Media:
Digital projector, board, flipchart, online contents, case studies

Reading List:
Recommended reading:
• Stark R; Seliger G, Bonvoisin J (2017): Sustainable Manufacturing - Challenges, Solutions and Implementation Perspectives , Springer
• Reniers G, Sörensen K, Vranken K (2013): Management principles of sustainable industrial chemistry, Wiley VCH
• McKinnon A, Browne M, Piecyk M, Whiteing A (2015): Green Logistics, Kogan Page
• Mangla S, Luthra S, Jakhar S K, Kumar A, Rana N P (2019): Sustainable Procurement in Supply Chain Operations, CRC Press

Further related reading, especially articles in international peer reviewed journals, will be provided in the kick-off meeting of the module.

Responsible for Module:
Fröhling, Magnus; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Sustainable Production (Vorlesung) (Vorlesung, 2 SWS)
Fröhling M [L], Heinrich V, Schirmeister J

Sustainable Production (Übung) (Übung, 2 SWS)
Fröhling M [L], Schirmeister J, Heinrich V
For further information in this module, please click campus.tum.de or here.

Module Description

CS0121BOK: Microbiology - Practical Course | Mikrobiologie - Übungen [CS0121BOK]

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
Immanenter Prüfungscharakter. Mitarbeit und Aufzeichnungen (20%), Identifizierungsbeispiel (40%), Schriftliches Colloquium am 6. Übungstermin (40%). Das schriftliche Colloquium (1h) besteht aus 5 Fragen zu je 6 Punkten. Notenschlüssel: 30-28 Punkte Sehr gut 27-24 Punkte Gut 23-20 Punkte Befriedigend 19-15 Punkte Genügend <15 Punkte Nicht genügend

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
Based on the training of working under sterile conditions and handling of the microscope, the following contents are offered: culturing, enumeration and identification of micro-organisms in different materials, staining and physiological differentiation. Finally, a microbiological identification of a bacterial culture is independently performed, and this, together with the evaluation of all bacteriological preparations and a written examination, forms the basis for marking.

Intended Learning Outcomes:
After successful completion of the course, the students are able to handle nonhazardous microorganisms. They can perform basic techniques applied in routine laboratories (staining procedures, microscopic analysis, phenotypic identification, biochemical typing). Further they are able to ascertain the microbial counts of feeds and foods.

Teaching and Learning Methods:
Laboratory

Media:

Reading List:
The necessary scripts can be downloaded from BOKUlearn.

Responsible for Module:
BOKU Bücher Carola, Mrkonjic Fuka Mirna, Pacher Nicola, Tanuwidjaja Irina Institut für Lebensmittelwissenschaften

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

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

Module Description

CS0122: Personnel and Organizational Economics | Personnel and Organizational Economics

Version of module description: Gültig ab summerterm 2024

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 examination will be given in the form of a written examination. The students should be able to describe theories, methods and concepts of Personnel and Organizational Economics. Students should be able to explain important examples from the academic literature. Type of examination: written, calculators are allowed, no additional tools allowed, duration of examination: 90 minutes. In order to be admitted to the examination, successful completion of a course assignment is required. In the assignment, students apply what they have learned and demonstrate in a group work that they can understand and present a current research paper.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Microeconomics, Advanced Microeconomics

Content:
In this course we develop a simple theoretical framework for thinking about firm-worker interactions (the principal-agent model). We use it to organize the large empirical literature on personnel motivation, personnel selection, and organizations as a whole. The relevant are:
- The principal-agent-problem
- Employee motivation
- Recruiting and wage setting
- Tournaments as incentives
- Teams

Intended Learning Outcomes:
After attending the module, students will understand the impact of individuals' incentives in organizations in general and at the workplace as a concrete example. Students will understand how to model diverging motives and incentives and how those may result in conflicts. In addition, they are capable of the interpreting and summarizing the empirical evidence on those topics. Students will learn about possible solutions to align the incentives within organizations and are capable of solving these problems with the help of models.

Teaching and Learning Methods:
The lecture will be mostly done by presentations. In addition, articles from newspapers and journals are integrated into the lectures. Together with the lecturer, students will study the content and methods of the academic papers. In the exercises, students will practice solving the learned models. This will either be done jointly on the blackboard or as work in smaller groups. Classroom experiments are carried out for selected topics.

Media:
Presentations, slide scripts, Articles, online lecture examples

Reading List:
Peter Kuhn, Personnel Economics, Oxford University Press;
Zusätzliches Literaturverzeichnis wissenschaftlicher Publikationen

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

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

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

Module Description

CS0122BOK: Practical Course in Process Engineering | Verfahrenstechnisches Praktikum [CS0122BOK]

For organizational details please refer to BOKU-Learn! Please read all documents and information on BOKU-Learn before the start of the course!

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:**	**Contact Hours:** 90

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

Description of Examination Method:
WG ETEM: 95% Arithmetic mean of the grades of the protocols. All modules have to be completed positively. 5% counts the oral performance at the introductory lectures. In the case of insufficient preparation / negative oral examination, participation in the practical course can be denied by one of the lecturers. All protocols must be positively evaluated. Protocols are due 1 week after the practicum. Protocols handed in after the deadline will be graded as "Not Sufficient". WG PTNR: Pre-Examination of basic knowledge in energy technologies (50%) + evaluation of protocol (50%). Note: All moduls must be completed sucessfully. Protocolls which are submitted after the deadline, will be evaluated negative!

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
recommended but not mandatory:
VU Introduction to process engineering
VU General process engineering
VO Mechanical and thermic process engineering
VO Heat and mass transfer

Content:
Various exercises, measurements and experiments will be carried out in small groups (max. 3 persons) at different exercise stations with a process engineering context. The practical course is offered by two working groups of the institute. You can choose one working group. The following exercise stations are offered:

WG ETEM (Energy Engineering & Energy Management: Kotik, Wolf):
-) Fluidized bed system,
-) Heat pump technology,
-) Flow measurement and
-) Dwell time measurement

WG PTNR (Process Engineering Renewable Resources: Grausam, Pfeifer, Hrbek):
-) Classificaton of particles,
-) Extraction,
-) Rectification and
-) Drying

Intended Learning Outcomes:
After successful completion, students will be familiar with various unit operations from a practical perspective and will be able to better understand theoretical relationships.

Students gain basic theoretical and practical knowledge of the exercise stations performed. The processes from process engineering and process technology demonstrated in the exercise stations are understood by the students and the students are able to calculate as well as evaluate techno-economic key figures.

Due to the experience with pilot plants, the students are able to design simple technical processes and to integrate real techno-economic aspects into the considerations. In addition, students are able to search for scientific/technical literature, excavate it and prepare technical reports.

Teaching and Learning Methods:
Workshop

Media:

Reading List:

Responsible for Module:
BOKU Grausam Anita, Hrbek Jitka, Kotik Jan, Pfeifer Christoph, Wolf Magdalena Institut für Verfahrens- und Energietechnik

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

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

Module Description

CS0123: Advanced Seminar in Behavioral Economics | Advanced Seminar in Behavioral Economics

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**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 seminar paper and an oral presentation with discussion. The seminar paper should cover 15-20 pages and is written in the style of a journal article. At the end of the module students present their work in a 30 minutes presentation. Weighting: Seminar paper 2, Presentation 1. The seminar paper demonstrates the student's ability to summarize the literature, explain research methods, present research findings and discuss them approbriately.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
-

Content:
This advanced seminar focuses on recent developments in Behavioral Economics. After being introduced to adequate research themes in the area of behavioral economics, students explore the academic literature on a chosen topic and develop their own research question. The topics are typically related to human behavior in an economic context and potential behavioral interventions.
Potential topics are:
-Green Nudges
-Social Comparison
-Choice Architecture

Intended Learning Outcomes:
The objective of the module is to equip the participants with the necessary skill and tools for a successful master thesis project.

Specifically, students will learn to:

- Read and understand recent research contributions
- Develop and pursue interesting research questions
- Conduct a literature review
- Eventually, design and conduct an experimental or empirical study
- Write a seminar paper in which they summarize the literature and explain research methods and results
- Present research findings and defend them in a discussion

Teaching and Learning Methods:
In an introductory session, the theme of the seminar is introduced and elaborated in detail.
The introduction will also introduce the relevant behavioral economics literature. Based on the introduction, students will develop their own research question and decide on the adequate research methods. During the term students have to reach different milestones (e.g., choose a topic, choose a research method, collect data, outline their paper, write the paper, present the results) on specific dates. Following the submission of the seminar paper, students will present and discuss their research question and findings. During all stages of the seminar students will be assisted by the lecturer(s).

Media:
Research papers; presentation slides

Reading List:
Cartwright, E. (2018). Behavioral economics. Routledge.
Davis, D. D., & Holt, C. A. (2021). Experimental economics. Princeton university press.
Additional current research articles will be provided during the seminar

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

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

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

Module Description

CS0123BOK: Socio-cultural Aspects of the Development of Rural Areas | Sozio-kulturelle Aspekte der Regionalentwicklung [CS0123BOK]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 60	**Self-study Hours:**	**Contact Hours:** 60

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

Description of Examination Method:
Written
A) Option Blended Learning: 4 positive in-class modules (short test and assessment of groupworks in each in-class module) OR B) Option E-Learning: written exam at the end of the semester

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
basic sociology knowledge

Content:
• Definitions, tasks and areas of regional management in Austria and abroad

• Actors, institutions, instruments and governance mechanisms

• Theories of regional development, collective action and social innovation

• Social and cultural capital as well as other types of community capital

• Tools and methods supporting development processes and development projects

• Best practice and assessment of development projects - with focus on socio-cultural aspects

Intended Learning Outcomes:
• Competences, methods and tools for practical regional development
• Insights into actors, organisations and processes of regional development

Teaching and Learning Methods:
A) Blended learning: i.e. self studying of knowledge, methods and tools based on text and audio files (on the learning platform BOKU learn); application of knowledge, methods and tools in different settings, such as case studies, team work and role play games (5 face-to-face meetings, minimum attendance is four)
B) E-Learning: self studying of knowledge based on text and audio files (on the learning platform BOKU learn) & written exam at the end of the semester (exam questions focus on real life cases and the application of learned methods and concepts)

Media:

Reading List:
Recommended Reading
Text and audio-files on BOKU learn site

Responsible for Module:
BOKU Altenbuchner Christine Institut für Nachhaltige Wirtschaftsentwicklung

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

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

Module Description

CS0125: Plant and Technology Management | Plant and Technology Management [PTM]

Version of module description: Gültig ab winterterm 2020/21

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:
Written exam (90 minutes): By solving problems from the thematic field of the module students have to prove their understanding of the management of industrial plants and technologies, their ability to techno-economic assessment and optimization methods and their analytical and verbal skills in the field. In the solution of the problems they need to demonstrate their ability to analyse technical systems, assess them from an economic point of view and apply techno-economic methods to solve planning and optimization problems arising in the life cycle of these plants.
In addition, they need to show that they are able to discuss the application of these methods in practice and to derive further research needs. Learning aids: pocket calculator.

Alternative: For smaller groups (<15 students) parts of the examination can be held in form of a case study. In this case studies, students have to demonstrate in a group work that they acquired the above mentioned abilitites by solving problems of practical relevance. This acknowledges the complexity of real world problems and the necessity to solve these in (interdisciplinary) team works. With the case study solution students have to provide a statement of the individual contributions to the solutions. Weighting: 1:1.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

Content:
The module contains units covering the following topics:
• Introduction to Plant and Technology Management
• Life cycle of industrial plants

• Analysis and modelling of industrial production systems
• Project management in engineering
• Network and facility location planning
• Investment estimation
• Cost estimation
• Plant and process optimisation
• Maintenance and repair
• Quality Management
• Re-location, dismantling and recycling

Intended Learning Outcomes:
The students are able to solve techno-economic analysis, planning, and optimisation problems associated with the life cycle of industrial plants. This comprises also linked topics of technology assessment and management. After completion of this module the students are able to identify and characterise these problems and structure them. Further, they are able to determine needed data and apply suitable methods for the solution of the problems. They discuss the achievements and shortcomings of these methods for a practical application. They are able to transfer these contents to an application in practice.

Teaching and Learning Methods:
Format: Lecture with tutorial to introduce, train and deepen the contents of the module.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individual assignments and presentation
The teaching and learning methods are combinded specifically for the treated topics. Typically, a thematic impulse or overview is given with a media-assisted presentation. Individual or group work assignments provide the possibility to apply the acquired competencies, to repeat and deepen these as well as to prepare the transfer to other fields.

Media:
Digital projector, board, flipchart, online contents, case studies

Reading List:
Empfohlene Fachliteratur:
1. Chauvel (2003): Manual of Process Economic Evaluation, Edition Technip
2. Couper (2003): Process engineering economics, Marcel Dekker Inc
3. Geldermann (2014): Anlagen- und Energiewirtschaft
4. Goetsch/Davis (2015): Quality Management for Organizational Excellence: Introduction to Total Quality, Pearson
5. Mobley/Higgins/Wikoff (2014): Maintenance Engineering Handbook, McGrawHill
6. Peters/Timmmerhaus/West (2003): Plant Design and Economic for Chemical Engineers, McGrawHill

Weitere Literaturempfehlungen werden in den Veranstaltungen gegeben.

Responsible for Module:
Magnus Fröhling

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

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

Module Description

CS0125BOK: Dendrology | Dendrologie [CS0125BOK]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Written
To pass the exam successfully 56 points out of a maximum of 110 points have to be achieved. Open questions on the topics of the lecture are asked. 110-97 = 1 96-83 = 2 82-69 = 3 68-56 = 4

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Biologie/Botanik Maturaniveau

Content:
Importance of woody plants for ecosystems and landscape; origin and differentiation of gymnosperms and angiosperms; the ice age as the cause of the depauperation of Europe in woody species; general features of spermatophyta; the gymnosperms and their Central European representatives; the dicots and their woody representatives

Intended Learning Outcomes:
Understanding the evolution of woody plants from the most primitive gymnosperms to the most evolved angiosperms; recognition of Central European woody species and some important exotics by means of conspicuous characteristics; sites, geographic distribution and commercial use of the species

Teaching and Learning Methods:
multimedia-supported

Media:

Reading List:

Responsible for Module:
BOKU Hesse Benjamin Daniel Institut für Botanik

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

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

Module Description

CS0126: Advanced Seminar in Circular Economy and Sustainability Management | Advanced Seminar in Circular Economy and Sustainability Management [ASCESM]

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**Contact Hours:** 60

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

Description of Examination Method:

Term paper: Students have to write a scientific paper on the given topic (1t e twiig t

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paper and a scientific presentation. In this process they are supervised, receive materials, thematic introductions, advise in scientific work and continuous feedback in the seminar sessions. The seminar closes with a final presentation.

Teaching / learning methods:
- Kick-off session: media-assisted presentation
- Individual work and feedback
- Interim presentations / workshops
- Final presentation
- Computer lab exercises using LCA software systems and Life Cycle Inventory Data bases.

Media:
Digital projector, board, flipchart, online contents, recent scientific journal publications, computer lab

Reading List:
Recommended reading:
• Gastel B; Day R A (2017): How to write and publish a sicentific paper, Cambridge University Press
• Glasman-Deal H (2009): Science Research Writing For Non-Native Speakers Of English: A Guide for Non-Native Speakers of English, Imperial College Press
• Skern T (2011): Writing Scientific English: A Workbook, UTB

Topic related reading, especially articles in international peer reviewed journals, will be provided in the kick-off meeting of the module.

Responsible for Module:
Fröhling, Magnus; Prof. Dr. rer. pol.

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

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

Module Description

CS0126BOK: Basics of Wood Science | Holzwissenschaftliche Grundlagen [CS0126BOK]

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	Language: German	Duration: one semester	Frequency: summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:**	**Contact Hours:** 60

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

Description of Examination Method:
Written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The importance of wood and wood science

Wood as a raw material - survey

Wood biology, ultrastructure of wood

Wood quality and silviculture

Wood species and their use

Wood chemistry

Wood physics: density, wood moisture relations, strength properties and stiffness

Primary processing: sorting, measuring, log break down, sawmill techniques

Solid wood products - survey

Wood based panels - survey

Intended Learning Outcomes:
Basics of wood science an technology as a base for othe lectures in the field of wood technology in the second part of the curriculum for students of forestry as well as students of forest producs

Teaching and Learning Methods:

Media:

Reading List:
Empfohlene Fachliteratur
Bosshard H H (1984) Holzkunde. Zur Biologie, Physik und Chemie des Holzes, Bd. 1-3, Birkhäuser, Basel

Grammel R (1989) Forstbenutzung. Technologie, Verwertung und Verwendung des Holzes. Verlag Paul Parey, Hamburg

Teischinger A, Fellner J (2000) Nutzhölzer. In: Pierer H (Hrsg.): Holzbauhandbuch. Österreichischer Agrarverlag, Leopoldsdorf

Download über boku learn, bzw. bei den Vortragenden

Responsible for Module:
BOKU Grabner Michael, Wimmer Rupert Institut für Holztechnologie und Nachwachsende Rohstoffe

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

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

Module Description

CS0127: Methods for Evidence Based Policy and Management | Methods for Evidence Based Policy and Management

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor	**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:
Assessment will be based on a written report. With the report students will demonstrate that they understand policy evaluations and are able to summarize them effectively. In the report, students work with an academic policy paper, which they replicate, critically evaluate and summarize for an interested lay audience. They may choose from a list of papers discussed in class or they may write about a paper they choose themselves with prior approval from the lecturer.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Microeconomics, Statistics, Empirical Research Methods

Content:
In this course students learn the fundamental skills of economic policy analysis.
Firstly, students will learn to evaluate the impacts of existing public policies (or natural experiments) by using two widely used econometric techniques, difference-in-difference (DiD) and regression discontinuity design (RDD). Secondly, students will learn about the role of experimental methods, such as randomized controlled trails, field experiments, and lab experiments, for the impact evaluation of economic policies.
The methods will be introduced based on research papers which cover areas of development economics, environmental economics, behavioural economics, labor economics, managerial economics, public economics, and political economics. For example, papers could cover diverse topics such as the impact of subsidies for renewable and low-carbon energy technologies or behavioural intervention like nudges to reduce energy consumption of private households.

Intended Learning Outcomes:
In this module, students will develop the ability to empirically evaluate the economic consequences of interventions and policies. At the end of the module, have a good understanding on common policy analysis tools and be able to compare the merits and disadvantages of different policies or interventions. They will be able to estimate the likely consequences of proposed policies.
Students will understand the nature of scientific evidence and how to translate this into management and policy advice. They can explain and apply the econometric methods used for economic policy analysis. Students understand the challenges of evidence-based policy advice and are able to critically asses existing studies.

Teaching and Learning Methods:
The module consists of a lecture and an exercise.

The lecture is designed as an interactive frontal lesson (PowerPoint, blackboard), as a large number of policy evaluations will be discussed together with the applied methods. Thereby, the lecture will also revisit and combine topics and methods covered in previous modules, e.g. Microeconomics, Environmental Economics, and Empirical Methods. During the exercise, students will gather data, manage datasets, and analyse them with STATA. In particular, during each exercise, students will go through a research/policy paper, its publicly available data, and replicate its basic findings (many economic and scientific journals publish their datasets for replication purposes). In groups, students will write short policy reports summarizing the academic papers and their own replications.

The lecture and exercise are designed to introduce students to the methods of policy evaluations and how to apply them.

Media:
Presentations, slide scripts, computer, statistic software (STATA)

Reading List:
Will be provided and is based on research and policy papers

Responsible for Module:
Prof. Andreas Pondorfer

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

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

CS01

Module Description

CS0128: Corporate Sustainability Management | Corporate Sustainability Management [CSM]

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/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:
Written exam (90 minutes): Students have to solve problems from the thematic field of the module. They have to prove their ability to use the right vocabulary, apply their knowledge on advanced topics in strategic and operational sustainability management.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
The Corporate Sustainability Management module includes a detailed discussion of the term sustainability (three-pillar model) and the history of the content. Based on this, the basic premises for sustainable management and sustainable economic activity are derived and discussed in a social, political, environmental, economic and corporate context. The national, European and international strategies for sustainable management are presented (e.g. bioeconomy, circular economy, green economy). Furthermore, established measurement concepts and key performance indicators (KPIs) for sustainability (e.g. resource productivity, life cycle costing) are discussed and applied to exemplary products and value chains within the framework of "Corporate Social Responsibility Reporting".

Intended Learning Outcomes:
After completion of the module, the students are able to understand sustainability concepts and to compare sustainability-oriented corporate profiles as a supplement to value-added corporate development. They can develop and apply concepts for the derivation, evaluation and operational integration of economic, ecological and social indicators. This enables the students to carry out

sustainability assessments based on common and innovative new measurement concepts and indicators and to apply the results in the company.

Teaching and Learning Methods:
The module includes a lecture and an exercise. During the lecture, the content is communicated by presentations and discussions. The lectures serves to communicate the theoretical basics and terms of sustainability management including small exercises for group work. The students are encouraged to further deepen their knowledge of the proposed literature. As the highest level of competence, the lecture communicates an understanding of the evaluation of various sustainability concepts for use in operational management.
In the exercise, the students deepen the knowledge they have acquired by case studies. The content of the lectures and exercises is deepened both in small working groups and in individual work. As the highest level of competence, the exercise conveys the step-by-step development and incorporation of sustainability concepts using case studies of real and fictitious company concepts to achieve strategic and operational targets for sustainable development of the selected company.

Media:
Presentations, slide scripts, case descriptions of real and fictitious companies with sustainability management problems

Reading List:
Müller-Christ, G. (2010) Sustainable Management. Introduction into Resource Orientation and Contradictory Management Rationalities. Baden-Baden: Nomos
Schellnhuber, H. J.; Molina, M.; Stern, N.; Huber, V.; Kadner, S. (2010): Global Sustainability. A Nobel Cause. New York: Cambridge University Press
Seliger, G. (2012): Sustainable Manufacturing. Shaping Global Value Creation. Berlin: Springer
Von Hauff, M.; Kleine, A. (2009): Nachhaltige Entwicklung (Sustainable Development). Grundlagen und Umsetzung (Basics and Implementation). München: Oldenburg Wissenschaftsverlag

Responsible for Module:
Röder, Hubert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Corporate Sustainability Management (Lecture) (Vorlesung, 1 SWS)
Röder H [L], Röder H

Corporate Sustainability Management (Exercise) (Übung, 3 SWS)
Röder H [L], Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0128BOK: Authenticity of Foods | Authentizität von Lebensmitteln [CS0128BOK]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Oral
oral It is recommended to give a PowerPoint presentation (approx. 20 min) on a selected topic (see list above) related to the “Authenticity of Foods”. ATTENTION: Please send your PowerPoint presentation in due time!!

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
* Introduction; brief insight into the history of adulteration; definitions
* Legal aspects (international and national legal situation; scientific basis; culture and ethos)
* Analytical aspects (sampling; analyses; interpretation, evaluation and presentation of results etc.)
* Review of methodology (physico-chemical, chemical, microbiological, immunological and molecular biological techniques) and their applicability to distinct foods.
* Examples for the control of authenticity of foods (control of composition, authenticity, genuineness, purity, quality, identity, labelling, generic terms, origin, etc.). e.g.:
- Control of composition, nutritional value, ripening index, indication of type, origin and characteristics of foods (e.g. Basmati rice)
- Origin of food (regionality; AMA-Gütesiegel; BIO; SUS + BOS; "A" and "A+A")
- Traceability of foods (legal regulations)
- Designation of origin (e.g. Steir. Kürbiskernöl; Marchfelder Spargel; Wachauer Marille)

- differentiation of proteins and fats of different origin (e.g. cacao butter, olive oil)
- species differentiation of dairy and meat products
- differentiation of rennets (from animals, plants, microorganisms; recombinant rennets)
- identity control of microorganisms (e.g. probiotic lactic acid bacteria)
- Authenticity of wine; beer; fruit juice; aroma; tea, coffee
- Authenticity of honey or maple syrup
- detection of whey and milk protein in foods
- Authenticity of foods by stable isotope ratio mass spectrometry (IRMS)
- detection of gluten, irradiation, genetic modification, heating processes in foods etc.

Intended Learning Outcomes:
After having successfully completed this lecture, students will be familiar with the fundamentals of food authenticity and traceability, and are able to apply this knowledge in practice. They will learn about product-specific aspects of adulteration control, e.g. crucial criteria (physical, chemical, etc.) for the adulteration of foods as well as appropriate methodology for detection and control of potential adulterations in distinct foods. Students will have basic knowledge and competence in the area of food authenticity and traceability, and will be able to use these skills also in the analysis and evaluation of the authenticity of foods.

Teaching and Learning Methods:
Anmeldung zur Prüfung persönlich bei Prof. Mayer unter helmut.mayer@boku.ac.at

Media:

Reading List:
Recommended Reading
Ergänzungsunterlagen (Handouts) werden während der Vorlesung an die HörerInnen ausgegeben!

Responsible for Module:
BOKU Institut für Lebensmittelwissenschaften Mayer Helmut Karl

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

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

Module Description

CS0129: Evidence Based Management and Policy | Evidence Based Management and Policy

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 210	**Contact Hours:** 90

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

Description of Examination Method:
Assessment will be based on a written report (50%) and a written project report based on a research project (50%). Both are about 15 pages long, but can vary depending on the topic.

With the report students will demonstrate that they understand policy evaluations and are able to summarize them effectively. In the report, students work with an academic policy paper, which they replicate, critically evaluate and summarize for an interested lay audience. They may choose from a list of papers discussed in class or they may write about a paper they choose themselves with prior approval from the lecturer.

The project work demonstrates that students can carry out their own interventions or evaluations. The project work is based on a research project in which a team of 2-5 students develops an empirical research question with policy relevance and then carries it out. The grading takes particular account of the quality of the research question, the research design (design of the evaluation), the analysis and the discussion of the results. The project work is designed in such a way that the individual contribution of each student is individually recognizable and assessable. For this purpose, the chapters on the research design and the results may be written together in the group, but the introduction, literature review and discussion of the results must be prepared individually by each student.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Microeconomics, Statistics, Empirical Research Methods

Content:
In this course students learn the fundamental skills of economic policy analysis.
Firstly, students will learn to evaluate the impacts of existing public policies (or natural experiments) by using two widely used econometric techniques, difference-in-difference (DiD) and regression discontinuity design (RDD). Secondly, students will learn about the role of experimental methods, such as randomized controlled trails, field experiments, and lab experiments, for the impact evaluation of economic policies.

Intended Learning Outcomes:
In this module, students will develop the ability to empirically evaluate the economic consequences of interventions and policies.

At the end of the module, have a good understanding on common policy analysis tools and be able to compare the merits and disadvantages of different policies or interventions. They will be able to estimate the likely consequences of proposed policies.

Students will understand the nature of scientific evidence and how to translate this into management and policy advice. They can explain and apply the econometric methods used for economic policy analysis. Students understand the challenges of evidence-based policy advice and are able to critically asses existing studies. They can successfully design and conduct their own independent research projects and derive policy conclusions from their results. In this module students deepen their ability to work efficiently and effectively in groups together and they learn how to communicate their own findings.

Students will understand the nature of scientific evidence and how to translate this into management and policy advice. They can explain and apply the econometric methods used for economic policy analysis. Students understand the challenges of evidence-based policy advice and are able to critically asses existing studies.

Teaching and Learning Methods:
The module consists of a lecture, an exercise, and a seminar.

The lecture is designed as an interactive frontal lesson (PowerPoint, blackboard), as a large number of policy evaluations will be discussed together with the applied methods. Thereby, the lecture will also revisit and combine topics and methods covered in previous modules, e.g. Microeconomics, Environmental Economics, and Empirical Methods. During the exercise, students will gather data, manage datasets, and analyse them. In particular, during each exercise, students will go through a research/policy paper, its publicly available data, and replicate its basic findings (many economic and scientific journals publish their datasets for replication purposes). In groups, students will write short policy reports summarizing the academic papers and their own replications.

The lecture and exercise are designed to introduce students to the methods of policy evaluations and how to apply them. The seminar is designed to push them a step further by asking them to design and conduct their own research project. In this project, students either identify or develop an intervention and then evaluate its impact. First, students decide on a relevant policy or management question. They develop a suitable (research-)design including an intervention, run a (pilot-)study and formulate policy advice based on the gathered evidence. Thereby, students apply the previously learned methods on a new topic.

In the seminar, students form groups and conduct under the supervision of the ITppe [illegible] ecyfem

Module Description

CS0129BOK: Agricultural Journalism | Agrarpublizistik [CS0129BOK]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Alternatively term paper or own media product Premature termination of the course results in a negative assessment.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
- gute Beherrschung der deutschen Sprache
- pflanzliche und tierische Produktion sowie Agrar- und Ernährungswirtschaft auf Bacherlorniveau

Content:
• basic skills of journalism (investigate, document, interview, formulate, edit, present)
• basic conditions of public relations (copyright and media right, fields of work, advanced training possibilities)
• media and their entelechy (newspapers, magazines, radio, television, internet, social media)
• (agrarian) media scene in Austria
• journalistic formats (news, report, feature, interview, survey; comment, squib, review)
• language (adequate phrasing, dependency of diction and sentence construction on target group)
• principles of design (lead story, headings, fotos, typography, layout)
• practical PR activities (press release, press conferences)

Intended Learning Outcomes:
Objectives:
• create basic knowledge of the tools for agrarian journalism and public relations
• gather first practical journalistic or PR experience
• training of verbal skills

Learning outcomes:
At the end of the course students are able to
• gather and process information appropriate for the respective medium,
• comply with relevant legal provisions,
• indepentently write contributions for print or online media,
• professionally apply media design principles.

Teaching and Learning Methods:
Didaktische Aufbereitung:
Vortrag, Übungsauftritte und Präsentationen, Kritik und Diskussion, Herstellung eines konkreten Medienproduktes

Media:

Reading List:

Responsible for Module:
BOKU Institut für Nachhaltige Wirtschaftsentwicklung Wytrzens Hans Karl

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

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

Module Description

CS0130: Basic Biology | Grundlagen Biologie [GBio]

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**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:
Learning outcomes shall be verified in a written test in which the students are to call up and remember important basics of biology without tools. Besides the students shall demonstrate that they are capable of recognizing and solving a problem in a given time by answering questions of comprehension relating to treated basic biological and biotechnological processes. The answering of the questions requires own formulations. Thus correct memory of important technical terms shall be verified as well. Exam duration: 60 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in biology and chemistry corresponding to basic knowledge of A-level students.

Content:
Signs of life, basics of cell biology, essential biomolecules, genetic information flow and basics of molecular genetics, important metabolic pathways (e.g. glycolysis, citrate cycle), transport processes, basics of biological systematics, use of microorganisms in industrial biotechnology, basic techniques of molecular biology

Intended Learning Outcomes:
After attending the module the students possess basic knowledge about structure and function of biomolecules. They know important components of procaryotic and eucaryotic cells and are able to differentiate between these forms of life. They know the basics of the genetic flow of information and the most important metabolic pathways and are able to assign bacteria, fungi and plants to higher- ranking systematic groups. Furthermore the students are able to convey technical terms and define processes and are able to use their knowledge to solve issues. They show a basic understanding for ecological challenges as a prerequisite for sustainable development.

Teaching and Learning Methods:
The teaching content is conveyed by means of lectures, based on ppt presentations and writing on the blackboard.

Media:
Presentation, writing on the board,

Reading List:
"Campbell Biologie"" von Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Pearson, 11. Auflage (2019)
"Brock Mikrobiologie" von Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl, Pearson, 15. Auflage (2020)

Responsible for Module:
Erich Glawischnig glawischnig@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen Biologie (Vorlesung) / Angleichung Biologie (Vorlesung, 2 SWS)
Glawischnig E [L], Glawischnig E
For further information in this module, please click campus.tum.de or here.

Module Description

CS0130BOK: Wood Materials Modification | Wood Materials Modification [CS0130BOK]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

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

Description of Examination Method:
written exam, written laboratory report

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Solid knowledge in wood physics, wood chemistry, and wood anatomy is required to follow this course.

Content:
The course provides an in-depth tretament of wood modification with special focus on thermal treatment, modification for wood preservation in archeological context, and chemical modification.

Intended Learning Outcomes:
The course will provide students with the ability to understand wood modification mechanisms and their effects on physical and biological wood properties.

Teaching and Learning Methods:
lecture with exercises

Lectures will be combined with experiments in laboratories. Additional self-study is required

Media:

Reading List:

Responsible for Module:
BOKU Institute of Wood Technology and Renewable Materials Grabner Michael, Hansmann Christian, Janesch Jan

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

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

Module Description

CS0131: Applied Methods in Chemistry | Praktische Methoden in der Chemie

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Exam achievement shall be done in the form of laboratory performance (e.g. preparation, performance (ca. 15 experiments depending on topic) and written evaluation (ca. 20 pages)) combined with a ten-minute presentation. Thus it shall be demonstrated that the working methods learned can be applied practically and transferred to the execution of test series. By means of the presentation communicative competence shall be verified when scientific topics are presented in front of an audience. Laboratory performance shall be evaluated with 2/3, the presentation with 1/3.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge and laboratory experience like in the modules of WZ1922/WZ1925 (LV4390 General and inorganic Chemistry und LV4400 Practical Laboratory Course General and inorganic Chemistry) and WZ1924/CS0215 (LV972 Organic Chemistry und LV936 Practical course in organic chemistry) shall be imparted.

Content:
The module makes use of different methods leading to the performance of test series. As a first step the students shall be lead to planning and performance of basic activities of laboratory practice by means of the lecture including thematisation of experiment design and research of literature as well as keeping the laboratory journal, how to use the most important and basic practical working methods as well as handling the most import laboratory equipment. In the next step the different working methods (including weighing, dissolving, diluting) shall be applied in supervised practical exercises. Subsequently individual test series shall be planned, processed and evaluated by the students after consultation with the lecturer.

Intended Learning Outcomes:
After having participated in the module units the students are capable of using basic working techniques (such as weighing, pipetting, dissolving, diluting) in the laboratory, of outlining simple test series, of performing an experimental design and of recognizing possible sources of errors.

Teaching and Learning Methods:
The module is successively built up using lecture, practical exercises and test series. In the lectures it is dealt with basic issues and methods necessary for the execution of subsequent exercises. After testing different methods in supervised exercises these methods will be transferred to a test series. Planning, performance and result evaluation will be summarised in a written assessment.

Media:
PowerPoint, Laboratory

Reading List:
Organikum, Lehrbuch der analytischen und präparativen anorganischen Chemie (Organikum, Textbook of Analytical and Preparative Anorganic Chemistry) (ISBN 978-3527339686) ; 1x1 der Laborpraxis (Basics of Laboratory Practice (ISBN 978-3527316571)

Responsible for Module:
Dr. Corinna Urmann

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

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

Module Description

CS0131BOK: Biodiversity and Ecology of Selected Animal Groups | Biodiversität und Ökologie ausgewählter Tiergruppen [CS0131BOK]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 60	**Contact Hours:** 60

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

Description of Examination Method:
Project planning, implementation and project presentation. Therefore, presence, participation as well as presentation are included in the assessment.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
None, except interest in ecology and zoological diversity.

Content:
In an introductory course, students learn to identify several selected animal groups (for this season: amphibians, snails, bugs and grasshoppers). After this introductory part students form small groups (2-4 students), each group specializing on one of the presented animal groups. In the following field part, the focus is on the comparison of near-natural habitats and those influenced by humans (comparison of the Vienna Lobau and the Danube Island). The students consider feasible survey methods for their animal group and specific questions. The students evaluate their surveys under expert supervision and present their results to the other students.

Intended Learning Outcomes:
Students are expected to acquire knowledge of the diversity of animal appearances and distribution in the Viennese area. They work out the principles of ecological concepts in the field of biodiversity, landscape use and species distribution.
Students will be able to identify species within the selected animal group, to survey diversity and to present the results in a scientific form.

These skills are the basis for projects in the field of natural conservation. Species knowledge is a prerequisite for assessing environmental impact. In general, the knowledge of the diversity of forms creates an increased readiness for ecological action or interest in the environment.

Teaching and Learning Methods:
On request/if interested, this course can also be held in English.

Media:

Reading List:

Responsible for Module:
BOKU Landler Lukas, Walcher Ronnie Institut für Zoologie

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

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

Module Description

CS0132: Energy Process Engineering | Energy Process Engineering [EPE]

Energy Processes Engineering

Version of module description: Gültig ab winterterm 2020/21

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:
Assessment takes the form of a written examination (90 minutes). Students demonstrate their ability to solve basic calculations and apply methods of process technology to different issues. In addition, some questions on energy and process technology plants are to bei answered in a written form.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Technical Thermodynamics

Content:
Within the modul the thermal and chemical components of power plants and process engineering plants such as combustion concepts, fuel treatment, exhaust gas purification, production of fuels from biomass and electricity generation concepts are explained. The basics of the design and calculation of steam generators, reactors and synthesis algae and the treatment of gases from gasification processes and their use e.g. in a fuel cell are explained.

Intended Learning Outcomes:
At the end of the module students can understand complex processes for energy and/or fuel production and are able to detect and explain the required needs (e.g. pressure, temperature) and process technologies.

Teaching and Learning Methods:
The module consists of lectures and tutorials. The contents will bei taught in lectures and presentations.

Media:
Lecture, blackbboard, presentation

Reading List:
Kaltschmitt, M.; Hartmann, H.; Hofbauer, H.: Energie aus Biomasse, 2. Auflage, Springer, ISBN 978-3-540-85094-6, 2009
Spliethoff, H., Power generation from Solid Fuels, Springer, ISBN 978-3-642-02855-7, 2010
Karl, J.: Dezentrale Energiesysteme, Oldenbourg, ISBN 3-486-27505-4, 2004/
Sterner, M.; Stadler, I.: Energiespeicher, Springer Vieweg, ISBN 978-3-642-37379-4, 2014

Responsible for Module:
Gaderer, Matthias; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Energy process engineering (Exercise) (Übung, 3 SWS)
Gaderer M [L], Gaderer M

Energy process engineering (Lecture) (Vorlesung, 2 SWS)
Gaderer M [L], Gaderer M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0132BOK: International Agriculture | Internationale Landwirtschaft [CS0132BOK]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Written and oral
Examination will be based on a country profile (environment, main crops, agricultrual trade, development potential) elaborated by each student. Alternatively an oral examination can be taken.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The lecture provides a fundamental understanding of the environmental and socioeconomic basis of international agriculture and related food production systems. The emphasis is on an understanding environment- crop-management interactions underlying adapted cropping systems in different parts of the world.

1st Unit:
Organizational planning
How to understand international agriculture?
=> Working with FAOStat.

2nd Unit:
World agro-environmental zones: Climate, soil and crop production.
=> Working with the Global Agro-ecological Zones Model (GAEZ).

3rd Unit:
Where to go? Economic strategies for world agriculture.
=> WTO and EU agricultural policies.

4th Unit:
Students' contributions: Snap shots of rural diversity.

5th Unit:
Agriculture, climate change and land degradation.

6th Unit
Guest lecture: Indonesia – Sustainable rice intensification.
Guest lecture: Soil health training in Mozambique – an example of research for development.

7th Unit:
Sustainable development goals. Visions and reality.

Intended Learning Outcomes:
Students will have a general overview on international food production systems, become familiar with economic and political strategies for international agriculture, work with online databases and get knowledge on current trends and challenges to sustainable rural management.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
BOKU Neugschwandtner Reinhard Institut für Pflanzenbau

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

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

Module Description

CS0133: Mechanical Process Engineering | Mechanical Process Engineering [MVT]

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:
Assessment takes the form of a written examination (90 minutes).
The students prove that they can solve computational problems and apply methods of mechanical particles and process engineering as well as answer questions about plants and apparatuses of mechanical process engineering.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Thermodynamics, Reaction Technology, Heat Transfer, Fluid Mechanics

Content:
The module teaches the basics necessary for the description of particle systems:
Particle size and shape, distribution functions, particle motion and interactions in heaps.
Furthermore, the basic operations applied to particles are presented: Crushing, mixing, separating, agglomerating, fixed and fluid beds, filtration.
For example, reference is made to applications in material and energy systems with regard to wood chipping, conveying, fermenter stirring and biomass combustion.

Intended Learning Outcomes:
After participating in the module, the students are able to apply the mathematical fundamentals of particle technology and to interpret the basic operations of particle process technology.

Teaching and Learning Methods:
The module consists of lecture and exercise.

The content of the module is conveyed during the lecture by speech and presentations. The students are encouraged to engage actively with the topics by integrating various self-search tasks and comprehension questions.
In the exercises, which take place in alternation with the lecture, serve for a stronger comprehension of the teaching contents. Hence, the students work on various calculation exercises and conduct different lab experiments in small groups.

Media:
Presentations, scripts, exercises

Reading List:
Bohnet, M., Hg.; 2014. Mechanische Verfahrenstechnik. Weinheim: Wiley-VCH-Verl. ISBN 9783527663569
Müller, W., 2014. Mechanische Verfahrenstechnik und ihre Gesetzmäßigkeiten. 2. Aufl. München: De Gruyter. Studium. ISBN 3110343568.
Rhodes, M.J., 2008. Introduction to particle technology. 2nd ed. Chichester, England: Wiley. ISBN 047072711X.
Schubert, H., 1990. Mechanische Verfahrenstechnik. Mit 36 Tabellen. 3., erw. und durchges. Aufl. Leipzig: Dt. Verl. für Grundstoffindustrie. Verfahrenstechnik. ISBN 9783342003816.
Schwister, K., Hg., 2010. Taschenbuch der Verfahrenstechnik. Mit 49 Tabellen. 4., aktualisierte Aufl. München: Fachbuchverl. Leipzig im Carl-Hanser-Verl. ISBN 3446424350.
Stiess, M., 1997. Mechanische Verfahrenstechnik 2. Berlin, Heidelberg: Springer Berlin Heidelberg. Springer-Lehrbuch. ISBN 978-3-662-08599-8.
Stiess, M., 2009. Mechanische Verfahrenstechnik. Partikeltechnologie. 3., vollständig neu bearbeitete Aufl. Berlin, Heidelberg: Springer Berlin Heidelberg. Springer-Lehrbuch. ISBN 978-3-540-32552-9.
Zogg, M., 1993. Einführung in die mechanische Verfahrenstechnik. Mit 29 Tabellen und 32 Berechnungsbeispielen. 3., überarb. Aufl. Stuttgart: Teubner. ISBN 9783519163190.

Responsible for Module:
Gaderer, Matthias; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Mechanical process engineering (Lecture) (Vorlesung, 2 SWS)
Gaderer M [L], Fang W, Herdzik S

Mechanical process engineering (Exercise) (Übung, 2 SWS)
Gaderer M [L], Fang W, Herdzik S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0133BOK: Local Knowledge and Ethnobiology in Organic Farming - Introduction | Local Knowledge and Ethnobiology in Organic Farming - Introduction [CS0133BOK]

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
Written
Quality of assignments in BOKUlearn (50%); Quality of mini research project (50%).
No final exam. Assignments to be completed in-between meetings and in BOKUlearn.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
English language skills on Master level.
This lecture is a preparation for the course Local knowledge and ethnobiology in organic farming – methods seminar (933.334), which focuses on the tools and methods that are needed to study local knowledge of organic farmers.

Content:
Organic farming was mainly developed by experiments and innovations of farmers and still today major developments in organic farming are advanced by organic farmers themselves. Such advances frequently stem from locally based knowledge, practice, beliefs, which is altogether called local knowledge.
This lecture introduces the concept of local knowledge, its characteristics, potential, value and its relevance for the sustainable management of natural resources, especially in organic farming. Practical examples will be presented from several ethnobiological subdisciplines such as ethnobotany, ethnomedicine, ethnopedology and ethnoclimatology.

Intended Learning Outcomes:
By completing this course, students will be able

• to explain the concept of local knowledge and the research areas that work with local knowledge;
• to explain the value and practical potential of local knowledge for organic farming;
• to apply an analytical framework for investigating local knowledge

Teaching and Learning Methods:
This course consists of five course units, five written assignments and one mini research project. The course units are composed of lectures, exercises and group discussions. Between course units, students complete assignments, including reflections on scientific papers, videos and talks and online investigations on specific topics, and submit written assignments. Students apply the analytical framework presented in the course to individual mini research projects, write a final report and present their findings in a poster presentation. The total expected workload for this course is 75 working hours (=3 ECTS).

Media:

Reading List:

Responsible for Module:
BOKU Vogl Christian R., Schwarzl Christina, Schunko Christoph Institut für Ökologischen Landbau (IFÖL)

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

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

Module Description

CS0134: Conceptual Process Design | Conceptual Process Design

Version of module description: Gültig ab summerterm 2024

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 exam performance is effected by an oral exam. It is reviewed whether the students know the fundamentals of conceptual design of chemical and biotechnological processes and if they can apply this knowledge on the design and evaluation of complex processes. The exam consists of two parts: (a) 30 minutes preparation through solving a given problem set (b) 30 minutes of oral examination. In the beginning of part (b) the results of part (a) are presented by the student. (total duration 60 min)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowleadge of thermodynamics and apparatusses used for fluid sparations processes. It is recommended to visit at least the course "Introduction of Process Engineering" first.

Content:
Basics of cenceptual design of processes; Basics of computational process design including calculation of process parameters; transfer of fundamental scale-up criteria towards real problem solving; Balancing of all process streams; Deepened knowledge of engineering principles.

Intended Learning Outcomes:
The students are qualified to understand the fundamentals of design, calculations, and balancing of chemical processes and fluid separation courses after the course. They will aquire knowledge of different challenges of process design and how to master them.

Teaching and Learning Methods:
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. In the exercises performed as part of the module learned theory

shall directly be applied with a practical orientation by means of calculations and examples from targeted aspects of process design and calculation. based on a direct comparison of a chemical process with it´s biotechnical alternative they learn to apply their knowledge on reality based challenges. Additionally they will be qualified by an in-depth knowledge of the design of operation units including calculation of process parameters based on utilization of selected software tools.

Media:
Panel, slides, scripts, practical exercises

Reading List:
Moulijn et al. (2013). Chemical Process Technology. – John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom.
Biegler et al. (1997). Systematic Methods of Chemical Process Design. – Prentice Hall.
Doherty, M.F., Malone, M.F. (2001). Conceptual design of distillation systems. – Boston: McGraw-Hill.
Gmehling, J., Kolbe, B., Kleiber, M., Rarey, J. (2012). Chemical Thermodynamics for Process Simulation. 1. Auflage. Weinheim: Wiley – VCH
Grassmann, P., Widmer, F., Sinn, H. (1997). Einführung in die Thermische Verfahrenstechnik. 3. vollst. überarb. Auflage. Berlin: de Gruyter.
Stichlmair, J.G., Fair, J.R. (1998). Distillation: Principles and Practice. – New York: Wiley – VCH.

Responsible for Module:
Burger, Jakob; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Conceptual Process Design (Lecture) (Vorlesung, 2 SWS)
Burger J [L], Burger J, Ibanez M, Staudt J

Conceptual Process Design (Exercise) (Übung, 2 SWS)
Burger J, Rosen N, Wolf A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0134BOK: Research Reports of Waste Management | Forschungsberichte zur Abfallwirtschaft [CS0134BOK]

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:** 30	**Contact Hours:** 30

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

Description of Examination Method:
Written
To obtain a positive evaluation it is required to attend the course at least 4 times and to participate at the discussions at the end of each term.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
Presentation and discussion of up-to-date and specific topics in waste management

Intended Learning Outcomes:
Objective: after completing this course participants are able to classify a specific topic and to discuss it on an expert level
The participants of this course get familiar with up-to-date and specific topics in waste management. After completion of this course, they are able to classify waste related topics and to critically discuss the contents of the speech in an expert level discussion.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
BOKU Huber-Humer Marion, Allesch Astrid Institut für Abfall- und Kreislaufwirtschaft (ABF-BOKU)

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

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

Module Description

CS0135: Cooperative Design Project | Cooperative Design Project

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**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:
The module concludes with the creation, presentation and positive evaluation of a final presentation. In the presentation, the students should present tasks, solutions, procedures in project management, and the project results in a concise form. The presentation should also show which contributions to teamwork have been made by the students themselves. In regular meetings with the supervisors, the individual achievements will be monitored.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The task describes a technical problem in the field of the use of biogenic resources for which the team has to find a solution. Examples are e.g:
1. preparation of a concept and design of a biogas plant for an agricultural business
2. Feasibility Study on the conversion of high performance packaging in space application from fossil-based plastics to bio-based plastics

Intended Learning Outcomes:
After successful participation in the module, students will be able to
- organize and evaluate the cooperation in a team with heterogeneous knowledge,
- delegate tasks,
- apply the basics of process and energy technology to practical questions,
- design a project in terms of time management, balancing, interaction, objectives,
- analyse projects and to present them to outsiders,
- lead works in a hierarchical organization

Teaching and Learning Methods:
The module consists of a project work, which is carried out in a cooperative team between Bachelor and Master students. Depending on the given task, the team size is 2-6 persons. The Master students assume the role of project leaders and are responsible for formulating and achieving the project goals. The Bachelor students carry out research, analysis and calculations and are supported by the Master students if required. Progress, role identification, and individual involvement are monitored in regular meetings with the supervisor.

Media:
Will be adapted to task at the project start by the supervisor

Reading List:
Rowe, S. (2015). Project Management for Small Projects, 2nd Edition. Oakland: Berrett-Koehler Publishers.
Specific literature will be announced by the supervisor before the project starts.

Responsible for Module:
Alle prüfungsberechtigten Dozenten/innen des Studienganges Technologie biogener Rohstoffe

Courses (Type of course, Weekly hours per semester), Instructor:
(Cooperative) Design Project (Praktikum, 5 SWS)
Burger J [L], Burger J, Elfaitory H, Rosen N, Staudt J

(Cooperative) Design Project (Praktikum, 5 SWS)
Gaderer M [L], Herdzik S, Huber B, Meilinger S, Putra L, Schenker M, Veiltl P

Cooperative Design Project (Prof. Zavrel) (Praktikum, 5 SWS)
Zavrel M [L], Beerhalter D, Borger J, Dsouza V, Geisler N, Marino Jara J, Oktay I, Stegemeyer U, van der Walt H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0136: Energetic Use of Biomass and Residuals | Energetic Use of Biomass and Residuals [EBR]

Version of module description: Gültig ab winterterm 2020/21

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:
Assessment consists of a written examination (60 minutes) based on the various potential uses of biomass for energy and a presentation on a concept students have developed individually regarding the use of biomass. The written part constitutes 50% of the grade and the presentation as well with 50%.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Technical Thermodynamics, Energy Process Engineering

Content:
Lectures are dedicated to potential technology for using biomass and residuals as a source of energy. In particular, heat generation, energy conversion, power-heat coupling and the process for generating gaseous and fluid sources of energy are discussed. In addition, the generation of biogas (fermentation process) is discussed in detail. However, as there is another lecture dedicated to this topic, this section will be restricted to the technical basics. Practical exercises focus on conception and planningof plants. As part of a seminar, participants should develop voluntary examples and assess these using an economic efficiency calculation. For the tutorial, students work individually in the group on a concept for biomass use. This concept is analyzed in regard to technical and economic feasibility with the result being presented and assessed in a presentation.

Intended Learning Outcomes:
After completion of the module, students are able to evaluate the various systems for use of biomass. They have got a broad overview of options. In addition, they are able to develop a relevant concept, argue in favour of it, and evaluate the economic profit.

Teaching and Learning Methods:
Lecture (talk by teaching staff) with media, tutorial on calculation of examples, presentation of a voluntary concept regarding biomass or residual use.

Media:
Presentation, script, examples, excursion

Reading List:
Script/
Kaltschmitt, M.; Hartmann, H.; Hofbauer, H.: Energie aus Biomasse, 2. Auflage, Springer, ISBN 978-3-540-85094-6, 2009
Karl, J.: Dezentrale Energiesysteme, Oldenbourg, ISBN 3-486-27505-4, 2004/

Responsible for Module:
Gaderer, Matthias; Prof. Dr.-Ing.

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

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

Module Description

CS0138: Research Lab Energy and Process Engineering | Research Lab Energy and Process Engineering

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor	**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 the practical course, the exam is taken by positively elaborated written internship reports. Thereby the correct presentation of the theoretical basics, the reproduction of the experimental procedure, and the correct data evaluation are essential. Thereby the students show that they understand basic processes and principles of energy and process engineering and that they can design and calculate corresponding transformations.
The students prove that they can execute and evaluate experiments with technical plants in small groups.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Chemical reaction engineering, Fluid separation processes, Energy Technology

Content:
Experimental methods used in research. These include e.g. phase equilibrium measurements, elucidation of reaction kinetics, classification of particle sizes.

Intended Learning Outcomes:
After graduation of the practical course, the students are able to independently design, execute, and evaluate research experiments in energy and process engineering (for exampel in reaction engineering or separation science).

Teaching and Learning Methods:
The acquisition of the basics is to be prepared by the literature handed out. Under supervision, students plan experiments to solve given problems. They will be supported and supervised by laboratory personnel during the setup and execution of the experiments.

Media:
Practical course script, laboratory equipment

Reading List:
Practical course script

Responsible for Module:
Gaderer, Matthias; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Lab Energy and Process Engineering (Praktikum, 5 SWS)
Gaderer M [L], Fang W, Gaderer M (Burger J, Kainz J), Huber B, Meilinger S, Schenker M, Veiltl P
For further information in this module, please click campus.tum.de or here.

Module Description

CS0139: Flowsheet balancing and simulation | Flowsheet balancing and simulation [ABS]

Version of module description: Gültig ab winterterm 2020/21

Module Level:	**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 examination is performed in the form of a seminar paper, in which an energy-technical task is to be solved with the software program. The learning result is checked by the way the work is carried out within the scope of the examination and the result achieved. The students prove that they can solve balancing tasks by using the software. It is proven that the students have understood the principles of balancing.

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge of the most important physical relationships (basic quantities with units, definition of pressure, temperature, enthalpy, entropy, etc.) must be available. Furthermore, the establishment and solution of mathematical systems of equations as well as the mastery of simple integral and differential calculus are assumed. Knowledge of mathematics, thermodynamics, energy and process engineering are required.

Content:
In this module, knowledge of the application of a selected software program (e.g. Aspen) for the calculation and design of energy engineering tasks is taught.
The selection of the software is based on the availability of the program and the availability of a teacher with the technical knowledge of the program.

Intended Learning Outcomes:
After the participation in the module the students are able to understand simple tasks for the calculation of energy systems with the software program, to build up, define and solve them in the used program environment (Aspen).

Teaching and Learning Methods:
The module consists of a seminar, because this form of learning is best suited for the introduction to software. The introductions take place in short presentations, which are followed by direct working with the program.

Media:
Presentations, slide scripts, program exercises

Reading List:

Responsible for Module:
Matthias Gaderer gaderer@tum.de Christian Schuhbauer schuhbauer@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

CS0140: Advances in Bioprocess Engineering | Advances in Bioprocess Engineering [ABE]

Advances in Bioprocess Engineering

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**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:
The learning outcomes are evaluated by a graded seminar presentation. The prsentation allows the students to assess the extent to which they can summarize a complex scientific work in the field of Bioprocess Engineering correctly and present it to an audience in a comprehensible and convincing way.

Repeat Examination:

(Recommended) Prerequisites:
Modules: Bioprocess Engineering, Downstream Processing, Conceptual Design of Bioprocesses

Content:
The technical content of the course focuses on current research results in the field of Bioprocess Engineering (Fermentation, Downstream Processing, Scale-up). This seminar focuses on particularly sustainable bioprocesses that, for example, use agricultural residues, are less harmful to the environment or protect the climate.

Intended Learning Outcomes:
The students know the current and relevant methods and applications of Bioprocess Engineering and are able to evaluate and classify them. Students can acquire, present and critically discuss relevant technical literature.

Teaching and Learning Methods:
First, a selection of current publications is made and a preliminary discussion of the respective topics with the students takes place. The students then work out a presentation which they then present and discuss in the seminar.

Media:
presentations, publications

Reading List:
will be given out at the start

Responsible for Module:
Michael Zavrel

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

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

Module Description

CS0140BOK: Technology of wood processing (Exercise course) | Technologien der Holzverarbeitung (Übung)

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
oral examination, written test (laboratory part)

Repeat Examination:

(Recommended) Prerequisites:

Content:
Characterization of the raw material wood and principles of converting the raw material wood into a material and products. Principles of slicing, sawing, milling, chipping etc. drying and glueing.

Laboratory exercises to the address issues.

Intended Learning Outcomes:
Understanding of the relationship of wood as a raw material and the process chain wood and the approbiate technologies. Knowlegde of the most common wood based materials, their properties and potential applications.

Teaching and Learning Methods:
laboratory

Media:

Reading List:

Secetariat Institute of Wood Science and Technology, script for the lab-units is handed out.
Wagenführ, A., Scholz, F., Taschenbuch der Holztechnik. Fachbuchverlag Leipzig, Leipzig 2005
Fellner, J., Teischinger, A., Zschokke, W.: Holzspektrum. proHolz Austria, Wien 2006

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

CS0142: Detail Process Engineering | Detail Process Engineering [DPP]

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 provided in the form of a term paper.
The students prove that they can solve specific tasks and computational tasks and apply methods of plant planning and safety analysis and answer them in writing.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Mechanical process engineering, materials engineering, mechanics

Content:
The module teaches the usual components used in plant engineering, such as machines, pipelines, valves, actuators and apparatus, and their function. Building on this, an introduction to safety and emission-relevant design guidelines such as e.g. steam boiler regulations, AD2000 leaflets, ASME, TA Luft and BimschV is given. As part of exemplary small-scale plant planning, specifications for media, machines, apparatuses and plants are drawn up and security analyzes are carried out. Their results are incorporated in the planning process. A key focus of the module concerns the practice-oriented aspect of technical plant safety as well as requirements within the scope of a CE certification in plant construction.

Intended Learning Outcomes:
After completing the module, students will be able to describe technical equipment components, perform apparatus design in terms of material, pressure, temperature, process demand according to AD2000 data sheets and steam boiler regulations, specifications for media, equipment and apparatus, VDI, DIN, To apply EN standards to the TA Luft and Bimsch laws and regulations, to describe the course of an ASME code, to describe the content and course of CE certification and

construction products, to apply system-related hazard and safety analyzes and safety-related solutions - for example by control technology Aspects - to be included in a plant design.

Teaching and Learning Methods:
The module consists of Lecture and Exercise.
In the lecture, the contents of the lectures will be conveyed during lectures and presentations. The students are encouraged by the seminar paper to actively engage with the topics.
The exercises serve to strengthen the comprehension of the teaching contents. For this exercise examples are processed.

Media:
Presentations, scripts, exercises

Reading List:

Responsible for Module:
Matthias Gaderer gaderer@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

CS0143: Hydropower | Wasserkraft [HyPo]

Version of module description: Gültig ab winterterm 2023/24

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 basics of energy generation from hydropower are assessed in a written examination (60 minutes).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basics in Mathematics and Physics
Basics in Energy Technology

Content:
"In-depth knowledge regarding energy generation from water power is taught in this module. The technologies used for this purpose will be presented from the following points of view:
• Physical basics
• construction types and system components
• Planning, erection and operation
• Power output and energy supply
In addition to technical features of plants, their effects on the environment as well as sustainability considerations are covered. Legal framework conditions as well as the economic aspects of using water power are discussed as well. "

Intended Learning Outcomes:
After completion of the module, students are able to characterize various types of plants for the use of hydropower. They can recognize and understand the plants from the point of view of energy and technology.

Teaching and Learning Methods:
The module consists of a lectures with integrated excercises. Lectures include talks and presentations as well as exercises. Students should be encouraged to study the literature and discuss about the topics. In addition, practical excercises with measurement equipment and an excursion may be included.

Media:
PowerPoint
Blackboard

Reading List:
Jürgen Giesecke, Emil Mosonyi: Wasserkraftanlagen. Springer, 2009. ISBN 978-3-540-88988-5

Responsible for Module:
Prof. Josef Kainz

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

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

Module Description

CS0144: Master's Thesis | Master's Thesis

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 450	**Contact Hours:** 450

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

Description of Examination Method:
The module examination consists of the preparation and positive evaluation of the Master´s Thesis (depending on selection of topics 25 to 75 pages).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
70 credits including all compulsory modules of the Master's program

Content:
consolidation of the knowledge of a specific topic in technologies of biogenic resources which is arbitrary in consultation with the supervisor / consolidation of practical skills in the lab / presentation of a research-based topic in the field of biotechnology

Intended Learning Outcomes:
After completion of the module, the students are able to work self-reliant on complex scientific problems on the basis of scientific methods and analytical thinking. The can present their results in a conclusive way, are able to discuss and to draw conclusions.

Teaching and Learning Methods:
During the Master’s Thesis, the students work on a scientific problem. At this juncture amongst others literature research as well as lab work and presentations are used. The actual teaching and learning methods depend on the respective problem and have to be discussed with the supervisor for each single case.

Media:
Specialist literature, software and so on

Reading List:
in consultation with the supervisor

Responsible for Module:
Alle prüfungsberechtigten Dozenten/innen des Studiengangs des Studienganges Technology of biogenic resources

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

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

Module Description

CS0147: Energy Efficient Buildings | Energy Efficient Buildings [EEB]

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:
Students demonstrate their knowledge and understanding of the differenct aspects of energy efficient buildings in form of a written examination (90 minutes). Students deliver definitions, describe and outline relevant processes, mechanisms and requirements of energy efficient buildings. Furthermore, students calculate different technical specifications and parameters based on provided practice-oriented examples.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics of physics, Basics of energy technology

Content:
The course focuses on the variety of options for implementation and/or enhancement of energy efficiency in new and existing buildings. This includes an introduction to relevant expert knowledge of energy and ressource efficient building materials and construction. In addition, typical measures for the enhancement of energy efficiency in existing buildings will be presented and evaluated concerning ther sustainability. The second part of the module is concerned with renerwable energy based systems for heat and warm water provision of buildings. Specific advantages and disadvantages of the presented technologies will be discussed in regards to building and usage type. In addition to the presentation of individual measures, it will be analyzed how concepts for energy efficient buildings can be include in modern building infrastructure and on living quarter scale.

Intended Learning Outcomes:
"After successful completion of the module, students acquire in-depth understanding of factors determining the energy efficiency of buildings and relevant legal requirements. Students can

evaluate the sustainability of actions to enhance the energy efficiency of (existing) buildings. In addition, students can understand as well as evaluate and explain advantages and disadvantages of systems for heat and warm water provision based on renewable energies in regards to building and usage type.

Students prepare short, practice-oriented tasks as homework in a project team (group work). Thereby, they acquire the ability to view and assess information within a limited period of time and solve practice-oriented questions. The edited information and results are passed on to the other participants accordingly with the focus on sharing results in the form of a written report as well as team work.

Teaching and Learning Methods:
The content is taught in lecturs and presentations. In addition, case studies and exercises will bei discussed. Students should bei encouraged to individual literature study and discussions on the theme.

Media:
PowerPoint, blackboard, videos

Reading List:
Bauer, M., Mösle, P., Schwarz, M. (201.): Green Building: Leitfaden für nachhaltiges Bauen. Springer Vieweg. Daten von Fachagenturen: BINE Informationsdienst, vom Bundesumweltministerium bzw. entsprechenden Landesministerien und anderen internationalen Organisationen.

Responsible for Module:
Vienken, Thomas; 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

CS0148: Measurement, Testing, Modeling | Measurement, Testing, Modeling

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** irregularly
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:
Examination in form of a final presentations (25% of the total grade) of the task of the individual groups and a written documentation report (75% of the total grade) of the group work. The report will have 4 to 5 pages per student. Students will prove their understanding and autonomous application of the teaching content (formulation and testing of hypotheses).

Repeat Examination:

(Recommended) Prerequisites:
Basics of physics
Basics of measurement technology

Content:
The course focuses on planing and conduction of laboratory or field experiments of applied energy and environmental research, e.g. ground water heat transport and heat storage. Therefore, the module starts with an introduction to relevant underlying technical and natural science contents. Students will work on an assigned practice-oriented tasks in the further module. Students will in groups formulate working hypotheses to solve these tasks and will test the hypotheses by means of laboratory or field experiments. These experiments will be planned and conducted autonomously by students. Planing process includes modeling of respective experiments via existing analytical or numerical (using simulation software) solutions. Students will be able to use existing sensors for the eperiments or design basic measuring devices on their own. Students will critically evaluate obtained results (modeling and measurement results) and identify and quantify resulting uncertainties. Individual groups present results of their task and work approach as well as obtained results to the other students. Thereby, students will learn to critically question scientific questions and concepts.

Intended Learning Outcomes:
After successful completion of the module, students acquire in-depth understanding of formulating scientific hypotheses in regards to scientific questions. Students obtain skills to test these hypotheses using laboratory and field experiments. Students will be able to plan, this includes modeling of expected results via existing analytical or numerial solutions, and to conduct basic scientific experiments. Students will be able to critically evaluate measurement data and underlaying scientific concepts and present this to a group.

Teaching and Learning Methods:
After an introductory lecture, groups of students will review textbook and non-traditional textbook literature, e.g. tutorials and teach relevant aspects for their work between groups. Thereby, students take responsible to teach relevant content to peers.

Media:

Reading List:
Eden, K., Gebhard, H. (2014): Dokumentation in der Mess- und Prüftechnik. Springer Vieweg.
Daten von Fachagenturen: BINE Informationsdienst, vom Bundesumweltministerium bzw. entsprechenden Landesministerien und anderen internationalen Organisationen.

Responsible for Module:
Prof. Thomas Vienken

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

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

Module Description

CS0149: Renewable Resources in Medicine | Renewable Resources in Medicine

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 Assessment consists of a written examination (90 minutes)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Requirements for the successful participation is basic knowledge in chemistry, cell and microbiology, biochemistry, materials science and renewable ressources

Content:
The course provides basic knowledge on the human anatomy, cell biology on general and the cell membranes in particular. The interaction of materials with cell surfaces and tissue will be introduced. The general issues related to pharmacology and the fabrication of drugs from from renewable ressources will be discussed. The application of renwable resources as the main course topic in surgery, internal medicine, plastic and reconstructive surgery as well as wound dressings will introduced. Future tasks for the medical application of renewable resources are outlined. The legislative framework for application of medical products and fabrication will be discussed.

Intended Learning Outcomes:
The successful visit of this course enables the students to select materials from renewable ressources for relevant fields in medicine (skin, muscle, bone) and can particularly assess the valueof their applicability. They are able to apply the most important legislation in medical application and to validate the material reqeuiements for the application in humans (biocompatibility). They are able to identify and develop new concepts for sustainable materials

from renwable ressources in medicine due to their aquired medical, chemical and materials science knowledge and they can set the base for the potiental application of such materials.

Teaching and Learning Methods:
Lecture (talk by teaching staff) with media, seminar on case studies

Media:
Presentation, script, examples, case studies

Reading List:
The following literature is recommended: Buddy Ratner et al.: Biomaterials Science - An Introduction to Materials in Medicine, Elsevier

Responsible for Module:
Zollfrank, Cordt; Prof. Dr. rer. silv.

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

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

Module Description

CS0149BOK: BOKU music | BOKU Musik

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** two semesters	**Frequency:** winter/summer semester
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:
To be able to play (at least) one musical instrument

Content:
Bohemian and Moravian music for brass instruments, traditional marches, optional:symphonic music for brass instruments

Intended Learning Outcomes:
Knowing the interpretation of trained pieces of music
Implementation of the process of interpretation to other pieces of music

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

CS0150: PREP: Practical Research Experience Program | PREP: Practical Research Experience Program

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	Language: English	Duration: one semester	Frequency: summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

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

Description of Examination Method:
The module examination consists of the presentation of a scientific poster summarizing the main findings and results gained during the internship.. In a thirty-minute presentation, the students will explain the project, interpret the results in detail, and answer questions about their findings. The project supervisor will be present during the poster presentation and will grade the students' performance. Depending on the respective project, in addition of the poster presentation the students may have to submit a written summary of the results and/or have to present the results in a seminar of the research group seminar. Both, the written summary and the oral presentation may be graded in addition to the poster presentation. However, the score of the poster presentation must not be less than 70% of the overall score. The module is passed with a module grade better than 4,09.

Repeat Examination:

(Recommended) Prerequisites:
In this module, the student independently work on a research project under the guidance of an experienced scientist. This module requires advanced knowledge in the respective subject area. Therefore, only students who are enrolled in a university course in the respective field of science and have successfully completed at least two full full academic years can choose this module.

Content:
The PREP module can only be selected by students who are participants in the PREP exchange program of TUM. For all other students this module is not electable.
The PREP module is a blocked course starting at the beginning of June and ending mid of August. It includes the individually planned participation of students in a scientific working group. Here the students will independently work on a subtask from a scientific project under guidance. The project

will be created by an experienced scientist ahead of time, and the students will apply for a stay abroad to carry out the project while they are still at their home universities.
During the course of the project, the students will be part of the respective working group and directly supervised by a more experienced scientist. The supervisor first explains the project, places it in a larger context, explains the details and finally outlines a subtask that the student is to work on within the internship period. The size of the project is determined by the supervisor in such a way that a presentable result can be achieved within the time available.
When carrying out the project, the students usually work independently on their project. Therefore they have to adjust their workload to the progress of the project and demonstrate the ability to self-regulated learning.

Intended Learning Outcomes:
After participating in this module, the students will be able to apply subject-specific knowledge and methods to master a scientific research project within their field of study.
They have the ability to use their specialist knowledge to solve specific problems and to plan further investigations based on results and analyses. They are able to organize and schedule their work mostly individually and in accordance with the progress of the project. They are also able to validate and interpret the results. In addition, they are able to compare their own results to the findings of other researchers, identify weak points, and discuss their conclusions accordingly. Finally, they will be able to summarize and present their results to expert or lay groups, and, with instruction, are able to organize and prepare their data for scientific publication.
In addition to pure subject-specific skills and knowledge, the students acquire a high degree of methodological competence. With the help of these skills and knowledge, which can be applied independently of the subject, the students are able to work independently on complex tasks and problems, to practice problem-solving skills, to study self-regulated, and to improve their foreign language skills.
With regard to their social competence, they will have the skills to communicate with their colleagues and supervisors, to work together with them, and to achieve individual or common goals. They will have also improved their ability to work individually and well as in a team and they will have improved their social skills.

Teaching and Learning Methods:
The PREP module has the form of a project internship during which the students work on a part of a scientific question under their own responsibility and guidance. They carry out experiments or test series and then evaluate their results independently. An experienced scientist is available to each student, who will personally explain each step of the project. This also ensures that any question or problem that arises can be discussed sufficiently. The researcher will also advise the student in the use of expensive research equipment.

Media:
Depending on the project, the students will receive their work instructions based on the methods and technologies used in the respective research group. These instructions may be given in written form, orally, or by personal demonstration.

Reading List:
As the students participate in a scientific research project, they will obtain the required specialist knowledge by reading and analyzing scientific primary literature, e.g. publications in scientific journals. The students will be taught how to use online databases as well as how to obtain scientific literature from the university library.

Responsible for Module:
Chia-Leeson, Olivia olivia.chia-leeson@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

CS0152: Physical Chemistry | Physikalische Chemie [PhysChem]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 learning results are going to be proved in form of a written test (120 min). The students solve physical/chemical arithmetic problems and answer questions for definitions or physical/chemical relations. They prove that they have understood the basic relations of physical chemistry that are highlighted within the scope of the module and can use the systems of equations. Calculators are allowed additives. Other additives can be permitted by the lecturer as needed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
A-level student knowledge of mathematics (especially differentiation and integration) and physics

Content:
Basics of chemical thermodynamics: laws of thermodynamics, forms of energy (U, H, G, S), relations of formulas; chemical equilibrium and chemical reactions; properties of gases; phase transition of pure substances and multiphase systems; two component systems; selected boundary surface phenomena; basics of reaction kinetics

Intended Learning Outcomes:
After successful completion of the module the students know the laws of thermodynamics; they are able to make calculations concerning U, H, S and G; they understand phase diagrams of one and two component systems, can create charts and calculate the condition of equilibrium of simple systems; they can calculate with partial molar quantities in multi component systems; they can use ideal and real gas equations; they are able to form and solve equations related to the kinetics of chemical reactions and to determine the order of reactions;

Teaching and Learning Methods:
Teaching methods: in the lecture the teaching content is communicated by a talk of the lecturer, supported by PowerPoint and sketches on the blackboard in which the latter form is chosen to derivate complex relations. To a limited extent this can be completed for selected topics by self-study of the textbook by the students. In relation to the teaching content exercise sheets are disbursed on which the students work in self-study before the tutorials. The solution and discussion takes place in the tutorials. Learning methods: at the postprocessing of the lecture especially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the physical-chemical relations and practise the usage of the systems of equations.

Media:
PowerPoint, whiteboard, exercise sheets, textbook, optional: script

Reading List:
Lehrbuch: P.W. Atkins, J. de Paula, Physikalische Chemie, 5. Auflage, Wiley-VCH, 2013

Responsible for Module:
Prof. Nicolas Plumeré Dr. Doris Schieder

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

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

Module Description

CS0153: Introduction to Process Engineering | Einführung Verfahrenstechnik

Version of module description: Gültig ab summerterm 2020

Module Level: Bachelor	**Language:** German/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 exam performance is effected by a written test. Through comprehension questions it is reviewed whether the students have understood the basic priciples of process engineering. The students solve balance arithmetic problems and answer questions regarding the definitions and relations of material and energy balances. The students prove that they have understood the basics of conceptual process design by selecting suitable process units for a given separation task and by drawing of the process flowsheet. Non-programmable calculators and a handed-out formulary are allowed aids. Exam duration: 90 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Mathematics (WZ1601)

Content:
Most important unit-operations: reactors, distillation, extraction, crystallization, absorption, membranes, filtration, evaporatoin. Material und energy balances of single units and whole processes. Conceptual process design.

Intended Learning Outcomes:
After sucessful completion of the module the students know the most important separation technologies of process engineering; the are able to balance them with respect to material and energy; they unterstand basics of reaction engineering; they can safely select unit operations and decribe their mode of operation.

Teaching and Learning Methods:
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Presentations, slide scripts, exercises

Reading List:
Worthof & Siemes: Grundbegriffe der Verfahrenstechnik: Mit Aufgaben und Lösungen, 2012.
Schwister & Leven: Verfahrenstechnik für Ingenieure: Ein Lehr- und Übungsbuch, 2014.

Responsible for Module:
Prof. Jakob Burger

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

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

Module Description

CS0155: Practical Course General and Inorganic Chemistry | Praktikum Allgemeine und Anorganische Chemie [Chem]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/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 the lab, the protocol is graded for 15 experiments of increasing complexity to include principles from general to inorganic chemistry. The protocol (10 page) should include a detailed explanation of the experiments performed and the experimental methods used. The protocol should clarify that the students understood the principles behind the experiments they performed. They should discuss the experimental results, with a particular emphasis on discussing the discrepancy between the experimental results obtained and those expected. Pass/Fail Grading of the Practicum. The practicum is considered passed only if the protocol listed above meets the criteria of completeness, accuracy, and comprehensibility/vividness more than 50% each, with feedback given on a first draft.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of chemistry, mathematics and physics, which correspond to the basic course knowledge of the gymnasiale upper school

Content:
General principles of inorganic and physical chemistry and experimental essays: Structure of compounds, acid / base equilibria, redox reactions, thermodynamics, reaction kinetics, selected reactions of inorganic chemistry.

Intended Learning Outcomes:
The students will know and understand chemical structures, aggregation states of compounds and the basic principles of chemical reactions. The students will get familiar with the practical work in chemical laboratories. They will be able to perform and formulate correctly chemical reactions,

and experimentally determine thermodynamic and kinetic aspects of chemical reactions. The successful participation in the module will enable the students to participate in the module of basic organic chemistry

Teaching and Learning Methods:
Laboratory experiments and equipment.

Media:
Laboratory equipment.

Reading List:
1) Practical Labor Script; 2) Theodore L., H. Eugene LeMay, Bruce E. Bursten, Chemie Studieren Kompakt, 10. aktualisierte Auflage, Pearson Verlag, München;

Responsible for Module:
Prof. Rubén Costa

Courses (Type of course, Weekly hours per semester), Instructor:
Labor-Praktikum Allgemeine und anorganische Chemie (Praktikum, 5 SWS)
Costa Riquelme R [L], Asin Vicente A, Atoini Y, Englberger H, Jaschik L, Maidl M, Mauz A, Nieddu M, Schieder D, Wolf P
For further information in this module, please click campus.tum.de or here.

Module Description

CS0156: Material Application for Renewable Resources | Material Application for Renewable Resources

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:
During the seminar, students independently work on a selected topic from the field of biobased materials and give an oral presentation with PowerPoint-handout (min. 10 slides). Group work is compulsory (3 – 5 persons). The students will implement their own online survey and present the findings in the context of the relevant literature in the presentation (each student has to present 5 minutes). The oral presentation shall be assessed according to content of the PowerPoint-handout and rhetoric aspects. The PowerPoint-handout summarizes the relevant literature, data, and key findings. Weighting: PowerPoint-handout 1, oral presentation 1.
The seminar work is not part of the written exam. However, midterm bonus points can be achieved which will have an effect on the individual final grade (-0,3).

Assessment requires a written examination (90 minutes). Students demonstrate their knowledge of physico-chemical properties and possible applications of biobased materials, as well as their environmental impact. Students are able to develop options for chemical synthesis and production processes of biobased plastics. No further tools are allowed in the examination.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in "Basics in chemistry " and “Biogenic Polymers”, as well as knowledge of materials and chemical compounds, or comparable knowledge of chemistry and physics.

Content:
Lectures give an overview the applications for biogenic resources in materials industry. Starting with the chemical composition and physic-chemical properties of the raw materials, the module introduces students to production and processing of biodegradable and non-biodegradable

bioplastics, as well as of natural fibre composites. It also covers material properties, relevant fields of application, their environmental impact, as well as current market trends.
In the seminar, students independently work on research papers and based on that, give a presentation to fellow students.

Intended Learning Outcomes:
After successful participation, students are able to assess opportunities and barriers for the application of biobased plastics, as well as their environmental impact compared to conventional plastics. Above all, they are competent to select suitable feedstocks, classes and types of materials, as well as processes to meet the technical requirements of a specific target product, having lower environmental impact at the same time.

Teaching and Learning Methods:
Lecture (talks using PowerPoint slide media, books and additional written material), seminar (independent work on a selected topic with subsequent presentation, peer instruction and constructive feedback).

Media:
Presentations, slide notes

Reading List:
Endres, H.J., Seibert-Raths, A., Technische Biopolymere, Carl Hanser Verlag, München, 2009
Pickering, K. L. (Hrsg.): Properties and performance of natural-fibre composites, CRC Press, Boca Raton 2008
Lewin, M.(Hrsg.): Handbook of Fibre Chemistry, Marcel Dekker, New York, 1998

Responsible for Module:
Fink, Bettina; 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

CS0156BOK: Chemistry and Technology of Sustainable Resources | Chemistry and Technology of Sustainable Resources

Version of module description: Gültig ab winterterm 2020/21

Cellulose Derivatives: cellulose acetate, carboxymethyl cellulose, methyl cellulose - preparation and application

Aging and Degradation: Basic reactions of cellulose degradation, mass-deacidification methods

Intended Learning Outcomes:
Chemistry and basic technology of sustainable resources, mainly based on wood components are covered.

Teaching and Learning Methods:
multimedia-supported
lectures are via ZOOM online

Media:

Reading List:
Ek et al. (Eds). Pulp and Paper Chemistry and Technology Vol. 1-4, De Gryuter
Fengel and Wegener "Wood",
Klemm et al., Cellulose and cellulose derivatives"
H. Sixta, Handbook of Pulp
Holik, Handbook of Paper and Board
J. Lehmann, Kohlenhydrate

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

CS0157: Cell Biology and Microbiology | Zell- und Mikrobiologie [MiBi]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 learning results are proved in a written test in which the students are to call up and remember important principles of biology without using additives. In addition the students prove that they are able to recognize and solve a problem in a certain time by answering the comprehension questions on covered basic cell and microbiology processes. Answering questions requires mainly the use of own formulations thereby the correct recall of important technical terms is additionally reviewed. During the examination the tasks are set in both languages and the processing of the examination tasks can take place either in German or English. Exam duration: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Basics of cell biology (cellular structure (cell wall, plasma membrane, endomembrane system, nucleus), differences between prokaryotic and eukaryotic organisms, theoretical basics of microscopy, transport processes, genetic flow of informations and basics of molecular genetics (e.g. DNA structure, transcription, translation, DNA duplication), basics of biological taxonomy using the example of selected production organisms (e.g. E.coli, S.cerevisiae, algae, fungi), usage of microorgamisms in industrial biotechnolgy (e.g. ethanol fermentation, ABE fermentation, protein synthesis)

Intended Learning Outcomes:
After having participated in the module units the students possess basic knowledge about the structure and function of biomolecules. They know important elements of pro- and eukaryotic cells and can differentiate between these life forms. They know the basics of the genetic flow of

informations and of the most important metabolic pathways and can grade bacteria, fungi and plants to higher-ranking systematic groups. After completion of the module the participants know different microorganisms, can describe their properties and understand basic cellular processes. Furthermore, the students can reflect biological terms, define processes and are able to use their knowledge to solve problems. They understand basic ecological challeges and prerequisits of sustainable development.

Teaching and Learning Methods:
The teaching contents are imparted by a talk of the lecturer, supported by PowerPoint and blackboard sketches.

Media:
PowerPoint, blackboard work

Reading List:
"Brock Mikrobiologie" von Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl, Pearson, 15. Auflage (2020)
"Campbell Biologie"" von Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Pearson, 11. Auflage (2019)

Responsible for Module:
apl. Prof. Erich Glawischnig

Courses (Type of course, Weekly hours per semester), Instructor:
Zell- und Mikrobiologie (Vorlesung, 3 SWS)
Glawischnig E [L], Glawischnig E
For further information in this module, please click campus.tum.de or here.

Module Description

CS0157BOK: Integrated Landscape Management and Nature Conservation | Integrale Landnutzung, Habitatmanagement & Naturschutz

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**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:
presentation and active participation

Repeat Examination:

(Recommended) Prerequisites:

Content:
introduction to nature conservation issues, rational and motivation for the lecture, different historic aspects of landuse management fragmentation, habitat and game management, edge effect, importance of pasture for biodiversity, management of nationalparks (e.g. NP Neusiedler See, NP Donauauen), adaptive management of NP visitors natural reserves network in Austria, concept of near to nature silviculture, Natura 2000, coarse woody debris management, population viability analysis, hemeroby versus naturalness

Intended Learning Outcomes:
There is a need for professional knowledge about goals and definition of nature conservation, silvicultural treatment plans, requirements of deer populations or aspects for conservation of biodiversity in discussions with NGO's. Students should become aquanted with ecological aspects of several land use practices and habitat management methods to be familar with the basic principles of nature conservation strategies.

Teaching and Learning Methods:
active participation in lecture 45%

content of seminar work 35%
presentation of seminar work 20%

Media:

Reading List:
HAMPIKE, U. 1991: Naturschutz-Ökonomie. UTB 1650. Ulmer, Stuttgart.
JEDICKE, E., 1994: Biotopverbund. Grundlagen und Maßnahmen einer neuen Naturschutzstrategie. 2. Aufl. Ulmer, Stuttgart.
KAULE, G, 1986: Arten- und Biotopschutz. UTB, Große Reihe, Ulmer, Stuttgart.
KIMMINS, H. 1992: Balancing Act: Environmental Issues in Forestry. UBC Press - University of British Columbia, Vancouver.
LEIBUNDGUT, H., 1990: Waldbau als Naturschutz. Haupt, Bern u. Stuttgart.
LEOPOLD, A. , 1992: Am Anfang war die Erde. Plädoyer für Umwelt-Ethik. Knesebeck, München.
MAYER, H. ZUKRIGL, K., SCHREMPF, W., SCHLAGER, G., 1987: Urwaldreste, Naturwaldreservate und schützenswerte Naturwälder in Österreich. Eigenverlag Institut für Waldbau, BOKU.
NOSS, R. F. & COOPERRIDER, A. Y. (1994): Saving Nature´s Legacy. Protecting and Restoring Biodiversity. Island Press. Washington, D.C., Covelo, California.
PLACHTER, H., 1991: Naturschutz. UTB für Wissenschaft: Uni-Taschenbücher; 1563. G. Fischer, Stuttgart.
SCHERZINGER, W. 1996: Naturschutz im Wald : Qualitätsziele einer dynamischen Waldentwicklung. Ulmer, Stuttgart.
SZARO, R. Z. & JOHNSTON, D. W., 1996 (Edit.): Biodiversity in Managed Landscapes. Theory and Practice. Oxford Univesity Press. New York, Oxford.

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

CS0158: Seminar in Innovation and Technology Management | Seminar in Innovation and Technology Management

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**Language:** English	**Duration:** one semester	**Frequency:** winter/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 learning results are going to be proved in form of a written thesis. The students write a theoretical and/or empirical thesis that addresses a current research problem in the area of Innovation and Technology Management. For this, they create a written paper, which, depending on the topic, ranges between 15 and 20 pages. They prove that they have understood the content of the current academic literature and are able to conduct empirical analyses.

Repeat Examination:

(Recommended) Prerequisites:
Entrepreneurship, Introduction to Innovation Management

Content:
Current research questions from the area of Innovation and Technology Management, e.g., Ecosystems, sustainable innovation, digitization

Intended Learning Outcomes:
After sucessful completion of the module the students are able to derive a current academic research questions and to respond to it by using the relevant literature in the area of innovation and technology management. The research questions are typically related to the promotion of sustainable innovation or entrepreneurship within ecosystems. In addition to the required literature analysis based on peer-reviewed academic journals, the students are able to conduct and interpret relevant empirical analyses such as regressions.

Teaching and Learning Methods:
Teaching methods: The students will be familiarized with the basics to conduct literature reviews in the area of innovation and technology management and to conduct and interpret empirical analyses such as regressions using statistical programs like STATA. The students apply these contents to their own research questions in the thesis. The students present their results in front of the other seminar members, and discuss their results with the group.
The students have to write a seminar thesis in order to learn how to write an academic paper based on a relevant research questions in the area of innovation and technology management.

Media:
Presentation, Power-Point Slides, Case Studies

Reading List:
Relevant research papers will be provided

Responsible for Module:
Doblinger, Claudia; Prof. Dr. rer. pol. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar in Innovation and Technology Management (Seminar, 4 SWS)
Doblinger C [L], Mess C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0159: Accredited Module 2 ECTS | Anerkanntes Modul 2 ECTS

Version of module description: Gültig ab summerterm 2019

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 2	**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

CS0159-2: Accredited Module 2 ECTS | Anerkanntes Modul 2 ECTS

Version of module description: Gültig ab summerterm 2021

Module Level:	Language:	Duration:	Frequency:
Credits:* 2	**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

CS0159-3: Accredited Module 2 ECTS | Anerkanntes Modul 2 ECTS

Version of module description: Gültig ab summerterm 2021

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 2	**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

CS0159-4: Accredited Module 2 ECTS | Anerkanntes Modul 2 ECTS

Version of module description: Gültig ab summerterm 2024

Module Level:	Language:	Duration:	Frequency:
Credits:* 2	**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

CS0159-5: Accredited Module 2 ECTS | Anerkanntes Modul 2 ECTS

Version of module description: Gültig ab summerterm 2024

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 2	**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

CS0159-6: Accredited Module 2 ECTS | Anerkanntes Modul 2 ECTS

Version of module description: Gültig ab summerterm 2024

Module Level:	Language:	Duration:	Frequency:
Credits:* 2	**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

CS0160: Accredited Module 4 ECTS | Anerkanntes Modul 4 ECTS

Version of module description: Gültig ab summerterm 2019

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:

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

Module Description

CS0160-2: Accredited Module 4 ECTS | Anerkanntes Modul 4 ECTS

Version of module description: Gültig ab summerterm 2020

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:

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

Module Description

CS0160-3: Accredited Module 4 ECTS | Anerkanntes Modul 4 ECTS

Version of module description: Gültig ab summerterm 2021

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:

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

Module Description

CS0160-4: Accredited Module 4 ECTS | Anerkanntes Modul 4 ECTS

Version of module description: Gültig ab summerterm 2023

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:

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

Module Description

CS0160-5: Accredited Module 4 ECTS | Anerkanntes Modul 4 ECTS

Version of module description: Gültig ab summerterm 2023

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:

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

Module Description

CS0160-6: Accredited Module 4 ECTS | Anerkanntes Modul 4 ECTS [CS0160-6]

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:

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

Module Description

CS0160-7: Accredited Module 4 ECTS | Anerkanntes Modul 4 ECTS [CS0160-7]

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:

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

Module Description

CS0161: Accredited Module 6 ECTS | Anerkanntes Modul 6 ECTS

Version of module description: Gültig ab summerterm 2019

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:

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

Module Description

CS0161-2: Accredited Module 6 ECTS | Anerkanntes Modul 6 ECTS

Version of module description: Gültig ab summerterm 2021

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:

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

Module Description

CS0161-3: Accredited Module 6 ECTS | Anerkanntes Modul 6 ECTS

Version of module description: Gültig ab summerterm 2021

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:

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

Module Description

CS0161-4: Accredited Module 6 ECTS | Anerkanntes Modul 6 ECTS

Version of module description: Gültig ab summerterm 2022

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:

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

Module Description

CS0161-5: Accredited Module 6 ECTS | Anerkanntes Modul 6 ECTS

Version of module description: Gültig ab winterterm 2022/23

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:

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

Module Description

CS0164: Basics of Numerical Methods and Simulation | Basics of Numerical Methods and Simulation [NumS]

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:
Examination shall be done in the form of a written test. As an aid the materials (lecture slides, example programs) used during the lecture may be employed. The students show by solving programming tasks that they know the basics of Matlab and are able to employ it to implement simple numerical methods. They apply these methods to specific technical problems in case studies. In doing so, they also demonstrate their capability to discern which way to solve a problem is appropriate.
Exam duration: 90 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
WZ1600 Physics, CS0 Mathematics

Content:
- Basics of programming using Matlab/Simulink
- simple numerical methods: Systems of linear equations, numerical integration & differentiation, finding zeros,
- numerical solution of differential equations
- application of methods by using case studies (e.g. mechanical and electric systems)
- basics of optimization

Intended Learning Outcomes:
After having participated in the module units the students understand basic concepts of various numerical methods. They can apply these methods to case studies presented in the course methods using self-created programs in Matlab/Simulink. In doing so, they have also learned

to implement different solutions and discern how appropriate to the problem they are. In simple cases, they are also able to evaluate their results in terms of plausibility and accuracy.

Teaching and Learning Methods:
The module consists of one lecture and an associated session of exercises. Contents of the lecture shall be imparted in a speech and deepened through independent preparation of exercises by the students. Processing of exercises is often done by independent preparation of programming tasks.

Media:
Presentations, writing on the board, demonstration of programmes/scripts

Reading List:

Responsible for Module:
Kainz, Josef; 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

CS0165: Supply Chain II | Supply Chain II

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 15	**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 consists of an exam (written, 60 minutes). Allowed aid is a non-programmable calculator.

In the exam students show that they can apply different approaches to problem solving - based on the understanding of the production and logistics planning in general. By means of exemplary objects from the production or logistics planning the students demonstrate that they can interpret planning problems and connections between different problems. Based on this knowledge students give recommendations to tackle the problems.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
BWL I - Controlling and Supply Chain

Content:
Selected contents deal with subproblems of:
• material requirements planning
• production planning: lot sizing questions, machine scheduling and sequencing in flow lines
• transport logistics: planning problems on the determination of tours, routes and packing schemes
• material logistics: inventory control policies and their extension to the stochastic case are elaborated
• strategic design of the logistics network
• interfaces to the predecessor resp. successor companies
• procurement stage: methods for the selection of suppliers
• distribution stage: installment of a suitable distribution network and the processes in the warehouse

Intended Learning Outcomes:
After participating in this advanced module, that enhances the basic modul in mangement, students will be able to
- understand the relation between different planning problems in production and logistics
- analyse specific planning problems of the strategic, tactical and operational level (for details see course content), as well as on how to apply respective solution approaches
- explain essential managerial tasks in production and logistics planning
- evaluate the economic impact of production and logistics related decisions (e.g. the tradeoff between holding and setup costs or between costs and service).

Teaching and Learning Methods:
The module consists of a lecture and exercise courses, which are provided weekly, as well as a voluntary tutorial offered biweekly. In the lecture the content is jointly developed with the students mainly by using slides. The exercise course repeats parts of the lecture contents by using examples. The tutorials are delivered by student teaching assistants for groups of up to 20 students which gives the student the opportunity to pose questions and receive immediately help from the teaching assistant.

The learning methods consist of lectures, (voluntary) tutorials and further literature.
The lectures are used to convey the theoretical foundation and include conducting exercises.
The tutorials accompany the lectures and deepen their content in an environment of small student groups. Students solve exercises on their own for most of the time and sometimes in group work.
During the lecture, further readings are suggested, to get a deeper understanding of the course content.

Media:
Presentation slides, skript (Production and Supply Chain Management)

Reading List:
Günther, H.O., & Tempelmeier, H. (2016), Produktion und Logistik, 9. Auflage, Springer
Ghiani, G., Laporte, G., Musmanno R. (2013), Introduction to Logistics Systems Management, 2. Aufl., Wiley

Responsible for Module:
Prof. Alexander Hübner

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

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

Module Description

CS0166: Advanced Organic Chemistry | Organische Chemie für Fortgeschrittene [AOC]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 students are able to demonstrate thier understanding of chemical reactions concerned in this course in a written exam with formula equations (90 min). The students show their understanding of different classes of natural compounds in formula equations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
module organic chemistry

Content:
Fossil oil and natural gas as primary source, crack- und steam reforming reactions, technical olefin chemistry, technical aromatic chemistry, polyolefins, nitrogen containing organic intermediates, carboxylic acids and oxygen containing intermediates in polyester production. Chemistry of carbonyl compounds and carbohydrates.

Intended Learning Outcomes:
After successfully managing this module, the students are able to understand the chemical reactions of our fossil based chemical production. They can present product trees, based on side products or associated products. By this knowledge they can identify intermediates up to the ready polymer product. The students can apply typical reactions of different organic compounds.

Teaching and Learning Methods:
Lecture by academic teaching personnel with PP-presentations, books, printed matter and others. Visit of production plants of nearby chemical industry to see typical industrial scale of reactions. In relation to the teaching content exercise sheets are disbursed on which the students work

in self-study before the tutorials. The solution and discussion takes place in the tutorials. At the postprocessing of the lecture especially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the chemical reactions of our fossil based chemical production and practise the presentation of product trees.

Media:
Powerpoint presentations, whiteboard, printed text of teaching

Reading List:
K. Weissermel, H.J.Arpe, Industrial Organic Chemistry, 4. Auflage, VCH Weinheim

Responsible for Module:
Prof. Herbert Riepl

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

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

Module Description

CS0168: Instrumental Analysis and Spectroscopy | Instrumentelle Analytik und Spektroskopie

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 135	**Contact Hours:** 105

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

Description of Examination Method:
The achievement of the intended learning objectives is assessed in a written final examination (90 minutes). The students demonstrate that they know and understand the basic concepts of the analysis methods covered. By means of concrete questions (sample tasks), the students show that they can also apply the acquired concepts in simple cases in a solution-oriented manner.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
In the module the basics of instrumental analysis are communicated. Instrumental analysis is also an essential building block in the development of chemical synthesis routes with increased sustainability. In the module, particular physicochemical characterization methods, basic principles of measurement and the setting of analysis instruments are disscussed in detail. In detail are these: optic/electricl/magnetic measuremnts, adsorption/desorption as basis for chromatopraphic techniques, adsorption/desorption related to vibrational spectroscopy and UV/Vis spectroscopy, nuclear resonance spectroscopy, mass determination and spectrometry, scatter methods, atomic spectroscopy and gas and high performance liquid chromatography. The handling of the received measuring results is explained by case studies.

Intended Learning Outcomes:
After visiting the required modul the students are able to select corresponding physicochemical analysis methods for underlying practical problems and to use these methods as needed. On the basis of the gained knowledge the students can analyse the obtained measuring results in a

competent way. They understand the importance of instrumental analysis for chemical syntheses in general and for sustainability in chemical synthesis in particular.

Teaching and Learning Methods:
The theoretical basics of the experiments conducted in the practical course will be delivered in the lecture part via ppt-presentations, movies and white board. In the practical course, the students will self-reliantly perform, document and analyse their experiments.

Media:
presentation, script, cases and solutions lab and equipment

Reading List:
script, sample solutions for the exercises

Responsible for Module:
Dr. Broder Rühmann

Courses (Type of course, Weekly hours per semester), Instructor:
Instrumentelle Analytik und Spektroskopie (Seminar) (Übung, 4 SWS)
Rühmann B [L], Riepl H, Rühmann B, Urmann C, Zieleniewska A

Instrumentelle Analytik und Spektroskopie (Vorlesung) (Vorlesung, 3 SWS)
Rühmann B [L], Riepl H, Rühmann B, Urmann C, Zieleniewska A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0169: Sustainable Supply Chain Management | Sustainable Supply Chain Management

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:

Exam: 50%
presentation: 50%

The combination of grading methods is necessary to evaluate the skills acquired in this course
- Written exam: 45 minutes written exam on presentation, recommended readings, and case studies
- Oral report/presentation: Preparation of an reports in tandem teams with presentation and discussion. The report can be provided as slide-based summary of the presentation. Objective is the preparation of and summary of a current research paper in the field of the lecture; the list of papers is provided at the beginning of the course; All parts have to be passed and cannot be retaken

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Bachelor Business administration; advanced knowledge of Mathematics, Statistics and Operations Research

Content:
The course covers decision-oriented aspects of SCM and discusses basic concepts, models, and methods for hierarchical planning in supply chains.This course content provides the foundation for a critical examination of planning systems from a theoretical and practical perspective. This builds the foundation to study case studies and papers with respect to sustainability.

Intended Learning Outcomes:
The students:
- know the conceptual structure of supply chain planning and understand basic concepts, models, and methods that are applied in supply chain management
- gain experience in the supply chain management using prevalent software systems and understand scope and limitations in supporting practical decision situations.
- hone their skills with respect to modeling and solving decision problems in sustainable supply chain management.

Teaching and Learning Methods:
Lecture (theory), tutorials with group work and presentation

Media:
Seminaristic tution using beamer, overhead projector, flipchart

Reading List:
Stadtler/Kilger/Meyr (2015): Supply Chain Management and Advanced Planning. Concepts, Models, Software, and Case Studies. 4. Aufl., Springer (Berlin).
Cachon/Terwiesch (2012): Matching Supply with Demand
Chopra/Meindl (2009): Supply Chain Management: Strategy, Planning, and Operation, Global Edition

Responsible for Module:
Alexander Hübner alexander.huebner@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

CS0170: Advanced Modelling and Optimization | Advanced Modelling and Optimization

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**Contact Hours:** 60

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

Description of Examination Method:
The examination is based on two project works (each 50% of evaluation).

The project works examine the understanding of the modeling and programming techniques discussed in the course. The project works includes, appling algorithms to solve problems, creating mathematical models for examplary problems, and discuss presented results. By this the students have to demonstrate that they have understood and can apply the mathematical models and methods to solve planning problems. The project paper serves the assessment of the understanding of the modeling and programming language.

For the project paper the participants get a randomly assigned fictive, extensive decision problem. For this problem, the following has to be prepared:
- a modeling of the problem as a mathematical program, as well as explanation of the program
- an implementation of the program in a known optimization and programming language
- a verbal and graphical explanation of the of the results for the original problem

The grading of the project paper is done by the following criteria:
- Correctness of modeling and implementation as well as of the results (60% of examination)
- Clarity, comprehensibility and efficiency of the implementation (30% of evaluation)
- correct language, typesetting and outer form of the paper (10% of evaluation)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Operations Research (CS0098)

Content:
This course is about modeling, solving and analyzing planning and decision problems using mathematial concepts. The course teaches the basics of linear, discrete and dynamic optimization. In addition, there is an introduction to optimization and corresponding programming languages, as well as teaching methods for analyzing and structuring algorithms, designing suitable object-oriented data structures, applying known standard algorithms and connecting them to other resources and programming environments.

Intended Learning Outcomes:
After successful completion of the module students are capable of modelling planning problems. Students learn to model real life business problems by applying mathematical programming techniques. They can independently implement mathematical models by using an optimization language and heuristical approaches. They are able to solve the models within the scope of a case study and can interpret the results. Furthermore, they deepen their knowledge in several different modeling techniques and basics of object oriented programming.

Teaching and Learning Methods:
The module consists of a lecture and exercise courses, which are provided weekly. In the lecture the content is jointly developed with the students mainly by using slides. The exercise course repeats parts of the lecture contents by using examples and offering the opportunitis to implement poblems individually. The excercises give the student the opportunity to pose questions and receive immediately help from the teaching assistant.

Media:
Script, Presentation slides

Reading List:
Hilier, F. and Lieberman, G., Introduction to Operations Research, McGraw-Hill, 2009
Popp, Andreas: Modellierung und Optimierung mit OPL. epubli, 2015
Schildt, H.: Java, A Beginner's Guide, 5th Edition, McGraw-hill, 2011
Winston, W.: Operations Research - Applications and Algorithms. 4th ed. (internat. student ed.), Belmont, Calif. (Duxbury), 2004.

Responsible for Module:
Alexander Hübner alexander.huebner@tum.de

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

Module Description

CS0171: Project Studies | Project Studies

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 12	**Total Hours:** 360	**Self-study Hours:** 330	**Contact Hours:** 30

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

Description of Examination Method:
Grading is based on a project work. The project work consists of a written project report in (30 pages + appendix) and a presentation (30 minutes). A student team of 2-5 students works on a specific problem set within a company or any other similar institution. The team runs through several project stages: problem definition, division of work/tasks, decision making processes, and realization. Throughout this process, the students show that they can develop appropriate strategies to cope with the set of problems. They show that they are able to compose the state of research. In addition they demonstrate their ability to develop their own specific approach for a solution based on scientific knowledge as well as methodical skills. Students demonstrate their ability within a team to manage resources, and deadlines through timely submission of the enumerated tasks. Students demonstrate that they are able to complete the tasks of their project in a team environment. Grading will especially take into account the overall working outcome of the project with respect to the initial problem set, the selection and application of the chosen methodology as well as the analyses and discussion of the main findings. The project work is set up in a way which enables the identification and evaluation of each student's individual contribution to the project's success.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in Business Administration

Content:
The project study consists of a specific problem statement or challenge which a company or any other similar institution is confronted with. This challenge may have a research related or practical character. The project study and its findings regarding the outlined problem set are based on students' academic knowledge gained through their study programs.

Examples of topics covered in the context of a project study include (non-exhaustive list):
- Analyzing potential sales volumes of a new market
- Identifying potential optimization actions regarding a supply chain
- Creating a financing concept for a company
- explaining problems of the logistic sector and developing appropriate optimization solutions
- Developing specific use cases for new electronic payment procedures and deriving appropriate product specifications
- Capturing and processing key performance indicators (KPIs) in controlling and the development of recommended actions
- Developing and conceptualizing a marketing strategy and deriving recommendations for implementation in the given market- or company environment

Intended Learning Outcomes:
After successful participation in the module, students are able to work on projects in a systematic and academic manner. Students are able to complete a project end-to-end throughout all project stages: problem definition, division of work/tasks, development of solutions, decision-making processes, realization, result presentation, and project report. Students obtain capabilities to apply theoretical concepts to the identified problem set and develop their analytical solution finding skills through team discussions. Students are able to exchange in a professional and academic manner within a team. They are able to integrate involved persons into the various tasks considering the group situation. Furthermore, the students obtain competencies in solution processes through their constructive and conceptual acting in a team. Students become able to manage resources, and deadlines through timely submission of the enumerated tasks in stages throughout their research projects.

Teaching and Learning Methods:
The team-based development (2-5 students) of the project solution encourages the students to deal soundly with an academic or practical subject based on their previously acquired academic knowledge. Team work is particularly suitable for tackling problem sets and writing a report, for developing constructive critique to others and for implementing appropriate solutions to these critiques. The project may happen at the premises of the respective company/institution or from a remote location. They are able to communicate the evolvement of the project by composing a project report and preparing a presentation of their solutions to the supervisors from the company as well as the university. The project is supervised jointly by mentors from the respective company/institution and the professor of the TUM School of Management. The supervision takes place through a kick-off meeting as well as an interim meeting. With regards to content the project study takes an approximate time of 9 weeks.

Media:
literature, presentations

Reading List:
Project Management Institute (2013): A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fifth Edition

Further literature based on the specific topic

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Projektstudium | project studies (Orientierungsveranstaltung, 1 SWS)
Hübner A [L], Hübner A, Lex E
For further information in this module, please click campus.tum.de or here.

Module Description

CS0172: Green Chemistry | Green Chemistry [GreenChem]

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**Language:** English	**Duration:** one semester	**Frequency:** summer 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:
Students gain knowledge of industrial processes and the principles of Green Chemistry. After passing the exam, students are able to identify essential principles of Green Chemistry in examples of industrial processes. They are able to make simple suggestions on how existing processes could be changed so that they would comply with the principles of Green Chemistry. The written exam has a duration of 90 minutes. Aids are not permitted.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics of chemistry, physics and biology

Content:
The module contains an introduction to the basics of environment-friendly 'green' synthesis routes for chemical products. The 12 basic principles of 'green engineering' will be covered. Sustainably production and treatment, process optimizations and innovative technological approaches and optimized separation methods will be discussed. The different processes will be presented with respect to relevant environment aspects, sustainability and energy- as well as raw materials consumption.

Intended Learning Outcomes:
After completion of the module, the students are able to describe the basic principles of environment-friendly and sustainable production of chemicals and demonstrate them at the examples of selected process chains. They can determine and present specific resource requirements with respect to energy, raw- and auxiliary materials as well as the yields during production, emissions into air, water and soil, as well as amounts of wastewater and solid waste.

They are alse able to couple syntheses to preceding and subsequent processing steps. Thus, they can assess the sustainabilities of production processes autonomously.

Teaching and Learning Methods:
Lecture with blackboard and slide presentations for the development of technical concepts. Seminar with written tests. Self-study is essential to consolidate the course contents.

Media:
Lecture, blackboard, slides, group work

Reading List:
Jiménez-González, Constable, Green Chemistry and Engineering, Wiley-VCH, 2010

Responsible for Module:
Riepl, Herbert; 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

CS0173: Master's Thesis | Master's Thesis [Master's Thesis]

M.Sc. Sustainable Management and Technology

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 850	**Contact Hours:** 50

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

Description of Examination Method:
The module examination is based on the preparation and positive evaluation of the Master's Thesis (depending on the topic, approximately 25 to 100 pages). The overall grade results from the grading of the Master's Thesis.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
70 credits including all compulsory modules of the Master's program

Content:
Deepening the knowledge of current academic literature on a specific topic, which can be freely chosen from the Sustainable Management and Technlogy program in consultation with the supervisor. Increase knowledge of appropriate research methods, as well as gaining further experience in their application.

Intended Learning Outcomes:
After completing the module, students are able to derive complex issues from the field of sustainable management and technology and to work on them independently on the basis of suitable scientific methods. In doing so, they demonstrate their ability to think analytically and work scientifically on their own. They are able to present their results coherently, discuss them and draw conclusions from them.

Teaching and Learning Methods:
First, the topic is specified together with the supervisor and a research question for the Master's Thesis is developed. Within the framework of the Master's Thesis, the students work on this

scientific question. Among other things, literature research, formal modeling and/or empirical methods are used. The actual teaching and learning methods depend on the respective research question are to be clarified with the supervisor in each individual case.

Media:
Academic literature, software and so on

Reading List:
in consultation with the supervisor

Responsible for Module:
Prof. Dr. Alexander Hübner

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

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

Module Description

CS0174: Marketing for Biobased Products | Marketing for Biobased Products [MBBP]

Version of module description: Gültig ab winterterm 2023/24

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 exam will be in form of an oral exam. By answering questions students have to show that they have understood and can apply the thaught specific principles of the marketing of bio-based products and industrial marketing. No additional tools are allowed during oral examination with a duration of 15 minutes. In a students' project, the students demonstrate the scientific analysis and possible solutions of specific questions related to a defined topic concerning the marketing of biobased products including industrial marketing. The results of the project work will be presented (20 min; passed/non-passed) by the students with subsequent discussion with the other students and the lecturers.
In this students' project, the students demonstrate understanding of specific questions related to a defined topic concerning the marketing of bio-based products and services. Students have to show in their presentation that they can analyse, solve and answer defined problems and questions related to this topic. Participants of the course show that they have done appropriate research work and are able to present their results. By answering follow-up questions related to their presentation they show that they have learned to put their research outcome into the relevant product and market context.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic know-how related to marketing and markets of biobased products is recommended

Content:
The content of the module comprises in one part specific aspects of the marketing of biobased products and services. This part includes in particular the modification of methods and instruments of strategic marketing to this specific group of products and services (e.g. holistic character

of change in raw material basis, use of by-products and cycle approaches), the particular target groups of such products and their behavior (e.g. characteristics of related target groups, attitude-behaviour gaps), adaptations in the marketing-mix (e.g. specific benefits, labelling and identification of biobased products, avoidance of greenwashing, biomass logistics) as well as specific aspects related to the marketing of sustainability-oriented products and services (e.g. sustainable consumption and its barriers, sustainability evaluation and standards, Fair trade).
Industrial marketing will be thaught in a second part of the module with a focus on specific tasks of industrial marketing, characteristics of different transaction types, specific features of transactions and service offers in the business-to-business area, as well as the combination of value chains, customer integration and service offers. Additionally, the procurement of business and state organisations will be considered with a focus on uncertainty and information as important factors in the buying process as well as concepts to analysing a buying center.
Besides, the students will use the taught methods and tools in a students' project in which actual questions and case studies related to the marketing of biobased products and services under consideration of industrial marketing will be analysed and answered.

Intended Learning Outcomes:
After attending the module, students will be able to use the instruments and methods of strategic and operational marketing related to biobased products and services thereby considering the specific aspects of industrial marketing in this context. They can deflect specific target groups for biobased products and services, analyse their behavior and derive targeted marketing strategies and their operationalization. Additionally, students can analyse the specific characteristics and challenges of sustainability-oriented products and services and are able to assess these in form of adapted marketing strategies and concepts. Students can evaluate the principles and specific tools of industrial marketing and can use these in the field of biobased products and services. Besides, students can distinguish important theoretical and practical approaches related to the procurement of business or state organisations and rate those with the specific characteristics of biobased products and services.

Teaching and Learning Methods:
The lecture will be done using Powerpoint with specifically worked out presentation scripts. In addition, published studies, scientific papers and statistical data will be integrated into the lectures. In the students' project, students use the taught methods and instruments of the marketing of biobased products and services, industrial marketing as well as their factual knowledge to analyse actual questions and cast studies related to the application fields of biobased products and services and derive adapted marketing strategies and concepts. They will present and discuss their approach and solutions with their colleagues and the lecturers.

Media:
Presentation slides, actual literature and studies, online discussion forum (all lecture materials are available via Moodle)

Reading List:
Specific literature and documents will be provided to the topics of the lectures as well as the topics that are worked on in the student projects

Responsible for Module:
Menrad, Klaus; Prof. Dr.sc.agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Specific aspects of the marketing of biobased products (Vorlesung, 1 SWS)
Menrad K [L], Menrad K

Applied marketing for biobased products (Projekt, 2 SWS)
Menrad K [L], Menrad K, Stelzl B

Industrial marketing (Vorlesung, 1 SWS)
Menrad K [L], Stelzl B
For further information in this module, please click campus.tum.de or here.

Module Description

CS0175: Advanced Mathematics 1 | Höhere Mathematik 1

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Learning outcomes are verified in a written exam. The exam consists of assignments in which the students are to demonstrate that they understand the mathematical methods conveyed as part of the module and are able to apply them to specific examples. Exam duration: 90 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge in mathematics corresponding to basic knowledge of A-level students.

Content:
Selected topics from one-dimensional analysis and linear algebra that are required in engineering. In particular: real and complex numbers, mathematical induction, sequences and series, limits, functions, continuity, single variable calculus, systems of linear equations, matrices, determinants. The methods are presented during the lecture and are applied to specific examples related to sustainability in the exercise classes.

Intended Learning Outcomes:
After completion of the module, students understand the fundamental concepts and essential methods from one-dimensional analysis and linear algebra. They are able to apply mathematical arguments in these fields independently. Moreover, they can apply the central proof techniques and concepts and comprehend their mathematical background.

Teaching and Learning Methods:
Lecture using digital presentation and/or blackboard to convey contents and methods. In addtion, concrete examples are discussed in the exercise classes through independent work and group

work in order to practice the adequate expression and independent application of mathematical arguments.

Media:
Blackboard, slides, exercise sheets

Reading List:
K. Königsberger, Analysis 1, 6. Auflage, Springer 2004.
C. Karpfinger, Höhere Mathematik in Rezepten, 3. Auflage, Springer Spektrum 2017

Responsible for Module:
Thielen, Clemens; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Höhere Mathematik 1 (Übung) (Übung, 2 SWS)
Thielen C [L], Meier F, Thielen C, Wittmann A

Höhere Mathematik 1 (Vorlesung) (Vorlesung, 2 SWS)
Thielen C [L], Thielen C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0176: Service Operations | Service Operations

Version of module description: Gültig ab winterterm 2021/22

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 is carried out in the form of a written test. This should demonstrate that the students can formulate quantitative decision models in the service sector and solve them with suitable methods.
• Type of examination: written
• Exam duration: 60 minutes

Repeat Examination:

(Recommended) Prerequisites:
Content of the module „Operations Research“ is recommended

Content:
• The basic concepts are presented with slide-based lectures. The quantitative models and methods are presented and illustrated by means of examples. Practical applications of service management, e.g. for hospitals, airlines, retail or the service sector.
• These contents form the basis for a critical consideration from a theoretical-conceptual and practical-application-oriented point of view. Current research papers and system-supported case studies are used for this purpose.
• In addition to an introduction to service management, the course also includes location planning, quality management, benchmarking, methods of process optimization, personnel planning, inventory planning and revenue management in the service sector.

Intended Learning Outcomes:
• The students get to know quantitative methods of operations management in the service sector and their application in practice.

• The students learn and understand the basic models and methods for service operations management (especially quality and process management as well as capacity planning) and revenue management (especially price differentiation, capacity control, overbooking control and dynamic pricing). It is also about getting to know the possibilities and limits of the models for use in practice.
• The students deepen their knowledge with regard to the modeling and solving of decision problems in the decision fields mentioned above.

Teaching and Learning Methods:
The basic concepts are presented with slide-based lectures. The quantitative models and methods are presented and illustrated by means of exercise examples, including practical applications in service management, e.g. for hospitals, airlines, retail or in general in the service sector. These contents form the basis for a critical consideration from a theoretical-conceptual and practical-application-oriented point of view. Current research papers, case studies and textbooks are used as the basis for this.

Media:
Presentations, black board work, exercise sheets

Reading List:
• Fitzsimmons, J.A. und M.J. Fitzsimmons: Service Management – Operations, Strategy, and Information Technology. McGraw Hill, New York, 3. Auflage, 2001.
• Klein, R. und C. Steinhardt (2008): Revenue Management – Grundlagen und Mathematische Methoden, Berlin/Heidelberg, Springer
• Talluri, K.T. und G.J. van Ryzin (2005): Theory and Practice of Revenue Management, Boston, Springer

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Service Operations (Lecture) (Vorlesung, 2 SWS)
Hübner A [L], Hübner A

Service Operations (Exercise) (Übung, 2 SWS)
Hübner A [L], Hübner A, Lex E
For further information in this module, please click campus.tum.de or here.

Module Description

CS0177: Discrete Event Simulation | Discrete Event Simulation

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 135	**Contact Hours:** 75

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

Description of Examination Method:
The examination consists of two individual tasks and a project work. The individual work is done as homework and is composed as follows:
• R-Statistics homework (10 % of the evaluation)
• AnyLogic homework (10 % of the evaluation)

The project work serves to evaluate the understanding in handling and application of simulations. For the project work the participants receive a randomly assigned extensive fictitious simulation problem. The project work consists of the presentation of the project plan, a project report, an oral presentation of 20 min and a discussion time of 10 min.

The evaluation of the project work is based on the following criteria:
• presentation of the project plan (10 % of the evaluation)
• written documentation of the project work (50% of the evaluation)
• presentation and discussion of the project work (20% of the evaluation)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in mathematics and statistics, especially in probability theory and probability distributions as well as descriptive and inductive statistics

Content:
• Basics of simulation
• Steps in a Simulation Study
• Conceptual Modeling
• Introduction to ARIS: Representation of processes using event-driven process chains

• Data collection and modeling of input data
• Introduction to R: Analysis of distributions
• Modeling and implementation of simulation models
• Introduction to simulation software (e.g. AnyLogic) and basic as well as advanced simulation techniques
• Visualization of simulations
• Verification, Validation and Calibration of a simulation
• Methods for determining the simulation setting
• Statistical methods for the analysis of simulation results

Intended Learning Outcomes:
Students
• apply their knowledge of probability theory and probability distributions
• are able to analyze production and logistic systems, represent processes and design proposals for optimization.
• apply the necessary methodological knowledge for the independent execution of simulation studies.
• are able to apply simulation software such as AnyLogic practically.
• can present results of a simulation study and derive concrete recommendations for action from their analyses.

Teaching and Learning Methods:
The module consists of a lecture and an exercise, which take place weekly. In the lecture, the contents are derived together with the participants. The exercise repeats the lecture contents with examples and deepens core concepts through independent simulation and computational studies of selected problems. The students are supported in solving the exercises by the tutors.

Media:
Presentations, cases and solutions

Reading List:
• Kelton, W. D., R. P. Sadowski, and D. T. Sturrock, Simulation with Arena, 3. Aufl., Boston (McGraw-Hill) 2003.
• Law, A. M. and W. D. Kelton, Simulation Modeling and Analysis, 4. Ed., Boston (McGraw-Hill) 2007.

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Discrete Event Simulation (Lecture) (Vorlesung, 2 SWS)
Schäfer F [L], Schäfer F, Tuma N

Module Description

CS0179: Advances in Metabolic Engineering | Advances in Metabolic Engineering [AMB]

Version of module description: Gültig ab summerterm 2023

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:
The learning outcomes are tested by a graded seminar presentation. The presentation allows the students to assess the extent to which they can summarize a complex scientific work in the field of Metabolic Engineering correctly and present it to an audience in a comprehensible and convincing way.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successfully completed exams for Cell- and Microbiology (CS0256) and Molecular Biology and Genetic Engineering (CS0257) modules or equivalent modules.

Content:
The technical content of the course focuses on current research results in the field of Metabolic Engineering. Molecular biological-methodical as well as biotechnological application-oriented work is dealt with, for example:
- Genome meditation using CRISPR / multiplex gene silencing approaches using CRISPRi or sRNA binding protein Hfq
- Multiplex genome editing through natural transformation (MuGENT)
- Biological sensor/reporter systems and switches
- Chassis organisms and minimal genomes by means of genome reduction and genome assembly of synthetic DNA fragments (top-down and bottom-up approaches)
- Implementation of novel capabilities and functions in established biotechnologically used organisms (e.g. C1-fixation, N-fixation...)
- Recombineering

- Strategies for sustainable production based on waist- or side streams

Intended Learning Outcomes:
The students know the current and relevant methods and applications of Metabolic Engineering and are able to evaluate and classify them. Students can acquire, present and critically discuss relevant technical literature.

Teaching and Learning Methods:
First, a selection of current publications is made and a preliminary discussion of the respective topics with the students takes place. The students then work out a presentation which they then present and discuss in the seminar.

Media:
Powerpoint, blackboard work

Reading List:

Responsible for Module:
Blombach, Bastian; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Advances in Metabolic Engineering (Seminar, 2 SWS)
Hädrich M, Vital S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0180: Concepts of Physics and Chemistry in Nature | Concepts of Physics and Chemistry in Nature

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor	**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 performance test will be in the form of a written examination. The students should demonstrate in the exam the understanding of the physicochemical principles governing natural systems. They will be asked about
Basic concepts of physical chemistry applied to energy conversion in natural systems and to the structure of biomolecules. No auxiliary means are allowed in the exam. 120 min examination time

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
This course will intend to consolidate basic concepts in Physics, Mechanics, Chemistry, and Mathematics having the focus on Nature examples. As such, basic knowledge in Physics, Chemistry, Mechanics, and Mathematics is required.

Content:
The module aims at providing in-depth knowledge to the students in the field of Physics and Chemistry applied to Biology. The focus on basic physical and chemical laws, concepts, principles and processes, including chemical bonding, chemical kinetics, spectroscopy, thermodynamics, thermochemistry, mechanics, optics, among others. The students will be able to apply them to understand the functionality of biological compounds/materials towards a more practical vision of Nature and its possible technological application.
The course will be divided into several topics related to the chemical structure of proteins, sugars, and other bio compounds, the formation of micro and macro self-assembled structures, light manipulation, heat management, mechanics, and electrical control. Each topic will be addressed refreshing the most important physical and chemical concepts followed by their relevance in the structural and functional aspects of these materials and their possible application in technology.

Intended Learning Outcomes:
At the end of the module students will be able to analyse biological systems using a physicochemical perspective; describe the different ways energy is transformed and used by natural systems (thermally, optically, mechanical etc.). They will be able to analyse the structure of proteins and other biomolecules and to identify the forces that define their functionality. They will be able to apply these concepts to understand bio-based and bio-inspired technologies.

Teaching and Learning Methods:
This course attendance includes lectures and exercises. For this purpose, powerpoint presentations, practical training materials, and open discussion seminars will be used.

Media:
The following forms of media apply: powerpoint, films, and blackboards.

Reading List:
1. Physical Chemistry for the Biological Sciences, 2nd Edition Gordon G. Hammes, Sharon Hammes-Schiffer, Wiley, 2015, ISBN: 978-1-118-85900-1
2. Physical Chemistry for the Life Sciences, 2ndEdition Peter Atkins and Julio De Paula Oxford University Press ISBN: 978-0-19-956428-6
3. Introduction to Biophotonics Paras N. Prasad Wiley 2003, ISBN: 0-471-28770-9.
4. Introduction to Biomechanics Duane Knudson Springer 2007 ISBN: 978-0-387-49311-4

Responsible for Module:
Costa Riquelme, Rubén Dario; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Concepts of Physics and Chemistry in Nature (Exercise) (Übung, 2 SWS)
Costa Riquelme R [L], Banda Vazquez J, Costa Riquelme R, Zieleniewska A

Concepts of Physics and Chemistry in Nature (Lecture) (Vorlesung, 2 SWS)
Costa Riquelme R [L], Banda Vazquez J, Costa Riquelme R, Zieleniewska A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0181: Advanced Electrochemistry | Advanced Electrochemistry

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
The learning results are proved in form of a written test (60 min exam duration) at the end of the semester. During the semester four online test to each of the main topics of this module are offered as voluntary mid-terms. The online tests are opened in the week after a main topic was concluded and remain open for five days. Up to 10% of the total number of points of the final examination can be credited as bonus points. The results of the online tests, which are held during the semester, determine the amount of bonus points. At least 65% of the points in the online test must be achieved in order to receive bonus points. This means the online test are not graded, the points reached in the online test only determine if and how many bonus points a student gets for their final examination. It is not possible to raise the grade from 4.3 or worse to 4.0. This should encourage students to continuously participate in the lectures and exercises which are very important to them. Based on questions to electrochemical aspects the students prove that they know the corresponding technical terms, designations and contents, that they understand the basic relations and are able to apply their knowledge concerning the reactions taking place within the scope of kinetic and thermodynamic connections. For that purpose, concrete computational tasks are assigned.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Participation in the Modules “Allgemeine Chemie” and “Physikalische Chemie”, “Mathematik” und “Physik” or similar courses. In general the student should have a basic knowledge of the reaction kinetics and thermodynamics.

Content:
- Fundamentals of Electrochemistry: Thermodynamics (electrochemical potential, electrode potential, Nernst equation), transport in solution (migration, diffusion, convection), thermodynamics of interface (the electrical double layer), electrochemical kinetics.
- Stationary Electrode Voltammetry (Potential pulse, linear sweep and cyclic voltammetry at macro- and microelectrodes) for determination of thermodynamic and kinetic parameters.
- Mass transport by convection (Rotating disc electrode and rotating ring/disk electrode), thin film methodology, ultra-micro electrodes, flow-cell electrodes.
- Electrochemical Impedance Spectroscopy (general principles, data acquisition and modelling, data analysis and interpretation).
- Implementations of electrochemistry (Renewable energy conversion, green electrosynthesis, Sustainable energy harvesting and storage)

Intended Learning Outcomes:
The students acquire knowledge of advanced concepts of electrochemistry. They master the most important analytical techniques for investigating and evaluating electrochemical systems and know how to control them. In particular, they understand where and when certain measurement techniques are used and what knowledge they gain from them. Based on this, they are able to investigate the same system under different limiting conditions. Furthermore, the students are familiar with the electrochemical processes relevant in industry, such as the conversion of renewable energies, green electrosynthesis and sustainable energy generation and storage, and can apply their theoretical knowledge to these processes. Furthermore, they know concrete application examples from research and industry and how these can be designed and optimised.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using text documents, PowerPoint presentations and blackboard sketches. This enables a way of delivering the teaching content to the students in detail and answering questions as soon as they arise. PowerPoint slides and blackboard sketches create a visual assistance to understand the complex relationships in electrochemistry. Additionally, the students are provided with exercises to consolidate what they have learned in the lecture. The solutions to those exercises are later presented and discussed by the students in a practice lesson.

Media:
Presentations, Moodle course with online tests, exercise sheets, question cataloge, PowerPoint, script

Reading List:
Elektrochemie, Hamann/Vielstich, ISBN: 3527310681
Electrochemical Methods: Fundamentals and Applications; Bard/Faulkner, ISBN-13: 978-0471043720

Responsible for Module:
Plumeré, Nicolas; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Electrochemistry (Übung, 1 SWS)
Plumeré N [L], Moore Y

Advanced Electrochemistry (Vorlesung, 2 SWS)
Plumeré N [L], Plumeré N
For further information in this module, please click campus.tum.de or here.

Module Description

CS0183: Energetic Use of Biomass and Residuals | Energetic Use of Biomass and Residuals [EBR]

Version of module description: Gültig ab winterterm 2020/21

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:
Assessment consists of a written examination (60 minutes) based on the various potential uses of biomass for energy and a presentation on a concept students have developed individually regarding the use of biomass. The written part constitutes 50% of the grade and the presentation as well with 50%.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Technical Thermodynamics, Energy Process Engineering

Content:
Lectures are dedicated to potential technology for using biomass and residuals as a source of energy. In particular, heat generation, energy conversion, power-heat coupling and the process for generating gaseous and fluid sources of energy are discussed. In addition, the generation of biogas (fermentation process) is discussed in detail. However, as there is another lecture dedicated to this topic, this section will be restricted to the technical basics. Practical exercises focus on conception and planningof plants. As part of a seminar, participants should develop voluntary examples and assess these using an economic efficiency calculation. For the tutorial, students work individually in the group on a concept for biomass use. This concept is analyzed in regard to technical and economic feasibility with the result being presented and assessed in a presentation.

Intended Learning Outcomes:
After completion of the module, students are able to evaluate the various systems for use of biomass. They have got a broad overview of options. In addition, they are able to develop a relevant concept, argue in favour of it, and evaluate the economic profit.

Teaching and Learning Methods:
Lecture (talk by teaching staff) with media, tutorial on calculation of examples, presentation of a voluntary concept regarding biomass or residual use.

Media:
Presentation, script, examples, excursion

Reading List:
Script/
Kaltschmitt, M.; Hartmann, H.; Hofbauer, H.: Energie aus Biomasse, 2. Auflage, Springer, ISBN 978-3-540-85094-6, 2009
Karl, J.: Dezentrale Energiesysteme, Oldenbourg, ISBN 3-486-27505-4, 2004/

Responsible for Module:
Prof. Matthias Gaderer gaderer@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

CS0184: Advanced Sustainability and Life Cycle Assessment | Advanced Sustainability and Life Cycle Assessment

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:
Written exam (90 minutes): Students have to solve problems from the thematic field of the module. They have to prove their ability to use the right vocabulary, apply their knowledge on advanced topics in life cycle and systems thinking, sustainability and and life cycle assessment. Learning aids: pocket calculator.

Alternative: For small groups (<15 students) parts of the exam can be held in case studies which have to be solved in a group. Thereby the students have to prove through the solution of an advanced problem that they are capable to apply methods and approaches of sustainability and life cycle assessment to emerging topics from the field. Weighting: 1:1.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
-

Content:
The module contains units covering the following topics:
• Systems and life cycle thinking
• LCA following the ISO 14040/14044 and ILCD standards
• Extension of Life Cycle Assessment to Life Cycle Sustainability Assessments
• Advanced Life Cycle Impact Assessment Methods such as for
- Land use and land use change
- Water use
- Resource use
• Attributional and consequential assessments

• Regionalisation of inventories and impact assessments
• Hybrid approaches
• Uncertainty handling
• Interface with Multi Criteria Decision Analysis
• Presentation and visualisation of results
• Handling of data uncertainty
• Current trends and developments
• Software systems and data bases for material flow analysis and life cycle assessment
• Case studies

Intended Learning Outcomes:
The students use advanced concepts and tools of sustainability and life cycle assessment to assess products, services and processesregarding their environmental impacts. Thus, they are able to gain a deeper understanding of their underlying material and energy flows and how they impact the environment. With these competencies development and improvement of systems, products and services can be supported, decision support delivered and communication with stakeholders aided.

Teaching and Learning Methods:
Format: lecture and (computer-based) exercises to introduce the content, to repeat and deepen the understanding as well as practice individually and in groups.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individual assignments and presentation
- Computer lab exercises using LCA software systems and Life Cycle Inventory Data bases.

Media:
Digital projector, board, flipchart, online contents, case studies, computer lab

Reading List:
Recommended reading:
• Curran, M.A. (2015): Life Cycle Assessment Student Handbook, Scrivener Publishing:
• Hauschild, M.Z. & Huijbregts, M.A.J. (2015): Life Cycle Impact Assessment (LCA Compendium - The Complete World of Life Cycle Assessment), Springer.
• Klöpffer, W. & Grahl, B. (2014): Life Cycle Assessment (LCA), Wiley-VCH.
• Recent articles from esp. International Journal of Life Cycle Assessment, Journal of Cleaner Production, Journal of Industrial Ecology, Environmental Science and Technology (to be announced in the lecture)

Responsible for Module:
Prof. Magnus Fröhling

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

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

Module Description

CS0186: Biochemistry | Biochemie [BC]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 learning results are proved in form of a written test (90 min exam duration). Based on questions to biochemical metabolic pathways and enzymology the students prove that they know the corresponding technical terms, designations and contents, that they have understand the basic relations and are able to apply their knowledge concerning the reactions taking place within the scope of kinetic and thermodynamic connections. For that purpose concrete computational tasks are assigned.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the modules "Organic Chemistry", "General and Inorganic Chemistry" and "Cell and Microbiology".

Content:
Enzymology: Within the module the students shall be introduced into basics of enzymatic catalysis. Nowadays, enzymatic catalysis and biochemical pathways represent a central building block in sustainable chemical synthesis, especially in the synthesis of biopharmaceuticals. In doing so theories relating to the course of enzymatic reactions, special aspects of kinetics and thermodynamics of enzyme-catalysed reactions, inhibition mechanisms as well as possibilities for calculating kinetic parameters shall be treated inter alia. Metabolism: Basic metabolic pathways such as glycolysis, citrate-cycle or gluconeogenesis shall be presented in the lecture. In doing so it is dealt with the general course of reaction cascades, thermodynamic aspects of energy generation as well as mechanisms of modulation of the individual paths.

Intended Learning Outcomes:
After sucessful completion of the module the students are able to describe and explain basic concepts, phenomenons and relations in the field of biochemistry. The students know important properties of proteins,understand the significance of kinetic parameters of enzymatic reactions and will be able to calculate them and apply to new issues (e.g. inhibition). Furthermore the students will be able to specify in detail basic metabolic pathways of the most important classes of substances, understand the particular steps and regulation systems of the respective paths. They have come to understand that biochemical reactions are usually reactions with very high sustainability, which can serve as models for sustainable chemical reactions.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations and blackboard sketches. Corresponding to the teaching content exercise sheets are prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentations, powerpoint, presentation script, exercise sheets

Reading List:
- Voet, D. , Voet, J.G., Biochemistry 4th Edition, Wiley-VCH, 2011;
- Nelson, D.L, Cox, M.M., Lehninger Principles of Biochemistry 5th Edition, WH Freeman, 2008;
- Berg, J.M, Tymoczko, J.L., Stryer, L., Biochemistry 6th Edition, 2006

Responsible for Module:
Sieber, Volker; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Biochemie (Vorlesung) (Vorlesung, 2 SWS)
Al-Shameri A [L], Al-Shameri A

Biochemie (Übung) (Übung, 2 SWS)
Al-Shameri A [L], Schulz M, Siebert D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0186BOK: Introduction to process engineering | Grundlagen der Verfahrenstechnik

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
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:
written and oral

Repeat Examination:

(Recommended) Prerequisites:

Content:
1) Processes and mass balances

2) Thermodynamic states, processes and the first law of thermodynamics

3) Humid air

4) Combustion balances

5) The second law of thermodynamics

6) Fluid mechanics

7) Heat transfer

8) Mass transfer

Intended Learning Outcomes:
The bases of chemical engineering are thermodynamics, fluid mechanics as well as heat and mass transfer. An introduction into these engineering sciences is offered by a combination of lectures and problem classes. The students shall learn to understand and to design simple technical processes.

Teaching and Learning Methods:

Media:

Reading List:
BOKUlearn

Responsible for Module:
David Wöß

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

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

Module Description

CS0187: Enzymes and Their Reactions | Enzyme und Ihre Reaktionen [EnzReact]

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**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 learning results are proved in form of a written test (90 min exam duration). Based on questions to biochemical metabolic pathways and enzymology the students prove that they know the corresponding technical terms, designations and contents, that they have understand the basic relations and are able to apply their knowledge concerning the reactions taking place within the scope of kinetic and thermodynamic connections. For that purpose concrete computational tasks are assigned.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the modules "Organic Chemistry", "General and Inorganic Chemistry" and "Cell and Microbiology".

Content:
Enzymes are higly efficient catalysts of biochemical reactions in living organisms. Thus, they also can make high efficient and selective new catalysts for a future, sustainable green chemistry. With respect to this, the course offers a broad overview of enzyme classes (oxidoreductases, isomerases, hydrolases, lyases, transferases and ligases) and of enzyme-catalysed reactions. Thereby different reaction mechanisms are examined from a chemical point of view and hence the usage of enzymes in simple chemical implementations and technical fields is derived and comprehensively illustrated. The role of complex cofactors (radical forming, redox-active, electron switching, ion stabilisating and so on) is introduced and hence the limitations of enzyme reaction are worked out. With data bases of enzyme reactions and thermodynamic dimensions (e.g. from the theory of group contribution methods) target compounds of enzyme reactions especially in the field of renewables utilization are made accessible.

Intended Learning Outcomes:
After sucessful completion of the module the students know and understand enzyme-catalysed chemical reactions and their meaning for an enhanced sustainability in chemical synthesis. Based on this knowledge the students are able to design single- and multi-stage enzymatic processes and to evaluate them by means of thermodynamic and kinetic reaction data. Students will thus have the fundamental knowledge for more advanced courses, especially on the bioengineering of enzymes as catalysts for new, sustainable industrial chemical processes.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations, blackboard sketches and working on data bases. Corresponding to the teaching content exercise sheets are prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentations, PowerPonit, lecture script, exercise sheets, computer based work and enzyme reaction data bases

Reading List:
Voet, D. , Voet, J.G., Biochemistry 4th Edition, Wiley-VCH, 2011; Perry A. Frey und Adrian D. Hegeman, Enzymatic Reaction Mechanisms, Oxford Univ Press, 2006; Reinhard Renneberg, Darja Süßbier, Biotechnologie für Einsteiger, 3. Auflage, Spektrum Verlag Heidelberg 2010; A. Liese, K. Seelbach, C. Wandrey, Industrial Biotransformations, Wiley-VCH, 2006

Responsible for Module:
Prof. Volker Sieber

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

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

Module Description

CS0187BOK: Rhetoric and representation techniques (AS) | Rhetorik und Präsentationstechniken (AW)

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 2	**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:
oral and written

Repeat Examination:

(Recommended) Prerequisites:

Content:
- You will develop a clear concept of where and how you are pesenting.
- You will learn to present the various phases of your speech with variety.
- You will train your pesonal power of expression, enthusiasm and firmness.
- You will practice the use of common presentation media.

Intended Learning Outcomes:
1. The students will learn the structure of a successful speech.
2. Proper use of body language when speaking.
3. Recognising simple group dynamic processes.
4. Recognising the direct benefits of various visual media.

Teaching and Learning Methods:
- Vortrag und Diskussion
- Einzel- und Gruppenarbeiten mit Präsentationen
- Übungen
- Feedback
- Selbst- und Fremdreflexion

- Kameraeinsatz

Media:

Reading List:
+ Balser-Eberle, V. (2009): Sprechtechnisches Übungsbuch. 28. Auflage, Wien: G&G Verlagsgesellschaft mbH.
+ Braun, R. (2012): NLP – eine Einführung. 4. Auflage, München: Redline Verlag.
+ Braun, R. (2015): Die Macht der Rhetorik – Besser reden - mehr erreichen. München: Redline Verlag.
+ Kellner, H. (1998): Reden, zeigen, überzeugen: von der Kunst der gelungenen Präsentation. München, Wien: Hanser.
+ Kommunikationslotsen (2013): Bikablo®2.0 – Visuelles Wörterbuch. 6. Auflage, Much.
+ Lehmann, G. und Reese, U. (1998): Die Rede - der Text - die Präsentation. Berlin, Bern, New York, Paris, Wien: Lang.
+ Lehrmittelstelle Herhold, E. (1998): Sicher präsentieren - wirksamer vortragen. 4., überarb. und erw. Aufl., Wien: Wirtschaftsverlag Ueberreuter.
+ Pöchtrager, S.; Duenbostl, Ch. und Stockinger, B. (2014): Ich spreche du staunst – Präsentieren in Studium und Beruf. Wien: facultas Verlags- und Buchhandels AG.
+ Sammer, P. (2015): Storytelling – Die Zukunft von PR und Marketing. 3. Korrigierte Nachdruck, Heidelberg: O'Reilly.
+ Von Tiesenhausen, M. (2016): Ad hoc Visualisieren – denken sichtbar machen. 2. Auflage, Göttingen: BusinessVillage GmbH.

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

CS0188: [PVT]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	Language: German	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 service is provided in the form of written protocols of the laboratory tests carried out (about 5 experiments and about 4 pages of protocol per experiment). In these, students should prove that they are able to understand the theoretical basis of the experiments, to document their experiments, and to evaluate their results. In addition, they should show that they can discuss deviations from the expected results and possible causes. Evaluation of the practical course as passed/failed. The practical course is only considered passed if the above-mentioned protocol meets the criteria of completeness, correctness and comprehensibility/clarity to more than 50% in each case, whereby feedback is given on a first draft.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Chemical and thermal process technology, Technical Thermodynamics, Chemical Thermodynamics and Mass Transport

Content:
Basic operations of process engineering, especially from the chemical, thermal and mechanic range e.g. destillation or particle distribution analysis.The content and the number of experiments are chosen from a of multiplicity of basic operations and rely on the available laboratory equipment.

Intended Learning Outcomes:
After graduation of the practical course, the students know basic processes and principles of process engineering (e.g. destillation, extraction, desiccation or particle distribution analysis and separation from a gas flow). They know how to design and calculate a chemical, physical or mechanic transformation. Furthermore, they know the process steps which are necessary for it.

Teaching and Learning Methods:
The acquisition of basic principles is prepared by handed out literature.
The student learns the theoretical understanding, the basic engineering of the experiment and the correct use of the installed measurement technique through the graduation of the practical course. The acquisition of these properties is proved at the day of the experiment and comfirmed by producing a report. Thereby also the ability is reviewed to evaluate and report data correctly.

Media:
Practical course script, laboratory equipment

Reading List:
Practical course script

Responsible for Module:
Burger, Jako; Prof. Dr.-Ing.: burger@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum Allgemeine Verfahrenstechnik (Praktikum, 5 SWS)
Burger J [L], Burger J, Rosen N, Staudt J, Winklbauer L, Wolf C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0188BOK: Wood and fibre material performance | Charakterisierung von Holz- und Faserwerkstoffen

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 2	**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:
oral and written

Repeat Examination:

(Recommended) Prerequisites:

Content:
Compounding, physico-mechanical characterisation, thermoanalysis, berst measurements, rheology

Intended Learning Outcomes:
Get acquainted with chemical, thermal, physical and mechanical methods to characterize natural fibres, natural-fibre materials, wood plastic composites, and polymer materials. Discussion of the theoretical background of different methods, and performing practical exercises and tests using actual materials.

Teaching and Learning Methods:
Lecture takes place in the Schwackhöferhaus, Institut für Holzforschung, Besprechungsraum.

Labs take place at IFA Tulln, Institut für Naturstofftechnik; TU Wien, Inst. für Mechanik der Werkstoffe und Strukturen; and Institut für Holzforschung.

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

CS0189: Bioprocess Engineering | Bioverfahrenstechnik [BPE]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 achievement of the desired learning goals is checked in a written final examination (90 minutes). The students show that they know and understand the basic concepts of biochemical engineering. With the help of concrete questions (e.g. calculations), the students show that they can also apply the concepts they have acquired in a solution-oriented manner in simple cases.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The lecture provides a fundamental overview of bioprocess engineering including all relevant process parameters, calculations and balances.This includes basic calculations of generation times, maximal specific growth rates as well as balancing of batch, fed-batch and continous fermentation processes. Furthermore, process relevant parameters such as oxygen transfer rates and heat transfer will be conveyed. Additionally, basic operation unit design as well as scale-up aspects will be examined. Examples of sustainable production processes are also given that use renewable raw materials, are climate-friendly and less harmful to the environment than conventional processes.

Intended Learning Outcomes:
The students acquire detailed and differentiated knowledge about concepts of various bioprocesses. Finally they are able to describe, calculate and design classical as well as complex bioprocesses. They will be able to evaluate the applicability of mathematical modelling of bioprocesses and will use this knowledge to analytically simplify highly complex process variants

Teaching and Learning Methods:
The lecture will be performed as ex-cathedra teaching to provide the students will all necessary fundamentals. Within the tutorial the students learn how to transfer this knowledge and get practically used with the content of the lecture. The tutorial will be used to internalise the theoretical knowledge based on case studies which allows the transformation on real-world as well as highly specific challenges of bioprocesses.

Media:
Slides, interactive quizzes, scripts, exercise sheets

Reading List:
Horst Chmiel, Bioprozesstechnik,
Spektrum Akademischer Verlag Heidelberg 2011

Responsible for Module:
Prof. Dr.-Ing. Michael Zavrel Nico Geisler

Courses (Type of course, Weekly hours per semester), Instructor:
Bioverfahrenstechnik (Übung) (Übung, 2 SWS)
Geisler N, Zavrel M

Bioverfahrenstechnik (Vorlesung) (Vorlesung, 2 SWS)
Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0189BOK: Post-harvest Technology | Post-harvest Technology

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
Written
Due to the corona situation, the exam takes place as an online exam. The mark results from the evaluation of the written exam. The mark of the lecture will be derived from the reached percentage of the points as followed. 90 – 100 % = 1 78 – 89 % = 2 66 – 77 % = 3 55 – 65 % = 4 0 – 54 % = 5 (failed) Duration of the written examination = 60min. The examiner reserves the right to make oral inquiries about the subject of the examination within the four-week assessment period. For the written exam you can bring calculator, ruler, and the formulary supplied on the bokulearn plattform.The use of any other tools and documents during the online exam is not permitted - this also applies to files on your computer! Please only do the online test using a PC! A working web-camera and a working microphone are required to participate!

Repeat Examination:

(Recommended) Prerequisites:

Content:
Importance of post-harvest technology for the food chain

Biological and physical principles of post harvest technology

Selected post harvest technologies in agriculture:

Treatment of seed (drying, cleaning, sieving,?)

Alternative methods of seed treatments (warm-humid, microwave, high frequency energy)

Drying technology (principles and application; Ddying of agricultural products)

Crop conservation with silage making (principles and processes)

Storage of crops (potato, fruit, vegetable,?); Principles and applications

Special post-harvest technologies in horticulture and viticulture

Intended Learning Outcomes:
Understanding of biological and physical properties of harvested crops and their comprehension

Qualification for systematic analyses of post harvest technology

Qualification for planning of post harvest technology

Evaluation of post-harvest technologies on engineering fundamentals as well as ecological and economic aspects.

Teaching and Learning Methods:
interactive lecture

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

CS0190: Practical Course Bioprocess Engineering | Praktikum Bioverfahrenstechnik [PCBPE]

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	**Language:** German	**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:
At the beginning of the practical course, there is an oral question to ensure that the students are sufficiently familiar or familiarized with the safety-related facts of the practicum script/ topic and the asscoiated equipment. The service is provided in the form of written logs of the laboratory tests carried out (about two experiments and at least ten pages protocol per test). In these, the students should prove that they are able to understand the theoretical basics of the experiments, to document the execution of the experiments and to evaluate their results. They should also show that they can discuss deviations from the expected results and possible causes. Assessment of the internship as passed/failed. The internship is only passed if the protocol listed above meets the criteria of completeness, correctness, and comprehensibility/clarity to more than 50%, whereby feedback is given on a first draft.

Repeat Examination:

(Recommended) Prerequisites:
Module Bioprocess Engineering

Content:
The practical course serves to deepen the content developed in the lecture Biochemical Engineering. In the internship, the theoretically conveyed basics are deepened by means of selected experiments. These practical experiments include the analysis of typical bioprocess parameters such as the determination of the specific growth rate. In addition, process-relevant offline parameters (e.g. the dry biomass) and online parameters (e.g. $O2$ and $CO2$ concentration in the exhaust gas) are recorded experimentally. Through the practical course, the students learn how to develop and optimize sustainable bioprocesses that are more climate-friendly than many conventional processes and help to reduce environmental pollution.

Intended Learning Outcomes:
After participating in the practical course, the students are able to work practically with bioreactors and scientifically evaluate fermentation processes. In addition, the students are able to transfer the calculations and practical experience they have learned to other complex processes and to use the resources of energy, water and raw materials efficiently.

Teaching and Learning Methods:
The practical course is based on carrying out cultivations in shake flasks and bioreactors. Bacteria and/or yeasts are used as the cultivation organism. Particular value is placed on the students' own initiative in order to promote a solution-oriented and independent way of working. The technical process characteristics are calculated and evaluated based on the recorded data.

Media:
slides, scripts, bioreactor

Reading List:
Horst Chmiel, Bioprozesstechnik,
Spektrum Akademischer Verlag Heidelberg 2011

Responsible for Module:
Prof. Dr.-Ing. Michael Zavrel Dennis Beerhalter Nico Geisler

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum Bioverfahrenstechnik (Praktikum, 5 SWS)
Zavrel M [L], Stegemeyer U, Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0190BOK: General environmental law | Allgemeines Umweltrecht

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
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:
Written
The exam will be held in German. You are allowed to use a dictionary if German is not your mother language. The exam is held in the form of a multiple-choice test and consists of 30 questions. Duration of the exam: 45 min Assessment scheme: From 50%: Sufficient (4) From 60%: Satisfactory (3) From 70%: Good (2) From 80%: Very good (1)

Repeat Examination:

(Recommended) Prerequisites:

Content:
The overall aim is to provide an overview of important areas of environmental law, of the principles of environmental law, its foundations in European and international law as well as of the fundamentals of environmental constitutional law.

Emphasis will be placed on the following areas of environmental law: plant permit law, water law, nature protection law, waste management law, environmental impact assessment law, genetic engineering law, air quality law and the basics of the EU Emission Trading System.

In addition, the course outlines the basics of the Austrian Environmental Information Act and the eco-audit system as well as of environmental private and environmental criminal law.

Intended Learning Outcomes:
After completing the course, the students are able to:
- Identify and describe the main areas of environmental law.

- Detect and assess questions of environmental law.
- In their professional activity, make informed decisions in compliance with legal requirements.
- Outline the instruments and principles of international, European and Austrian environmental law.
- Solve simple case constellations in environmental law independently.
- Analyse the legal framework of environmental policy discussion processes based on current European and Austrian legal developments.

Teaching and Learning Methods:
Interactive lecture
As far as possible, the contents of the lectures are prepared in discussion with the students and illustrated by small cases.

Media:

Reading List:

Responsible for Module:
Daniel Ennöckl

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

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

Module Description

CS0191: Downstream Processing | Downstream Processing [DSP]

Downstream Processing

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**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 teaching content will be evaluated by a written examination for the learning outcomes of the module of a duration of 60 minutes. Based on questions to definitions and methods of downstream processes of biologically inspired processes the students prove that they know the corresponding technical terms, designations and contents, that they have understand the basic relations and are able to apply their knowledge. Using calculations, the students also show that they can calculate and design downstream processing methods.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module Bioprocess Engineering

Content:
The lecture gives a basic introduction to the downstream processing technologies of bioprocesses, in which all relevant separation methods are discussed. The content ranges from the determination of the respective process variables to the design and scaling up of the technologies. One focus is on avoiding, minimizing and recycling waste streams in order to develop sustainable bioprocesses that conserve resources and do not pollute the environment. In the parallel exercise, the lecture content is deepened in the form of exercises to be worked on.

Intended Learning Outcomes:
After participating in the module events, the students are able to define the terminology of the processing technologies of bioprocesses. These include above all the different separation methods, which contribute significantly to the feasibility of fermentation processes and other biologically based manufacturing processes. At the end of the module, the students are able to

develop, design and implement economical and sustainable bioprocesses based on the application and implementation of these processing methods.

Teaching and Learning Methods:
The lecture takes place mainly as frontal teaching in order to familiarize the students with all the necessary basics, which they need for the assessment of targeted and sustainable downstream processes in the field of biotechnology. In the exercise, design tasks are worked on in order to learn how to calculate and design DSP processes.

Media:
slides, interactive quizzes, short films, scripts, exercise tasks

Reading List:
Harrison, Roger G, and others, Bioseparations Science and Engineering, 2nd edn (New York, 2015; online edn, Oxford Academic, 12 Nov. 2020), https://doi.org/10.1093/oso/9780195391817.001.0001, accessed 8 July 2024.

Responsible for Module:
Prof. X n / c,te o   e

Module Description

CS0191BOK: Conservation genetic analysis methods | Conservation genetic analysis methods

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
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:
Written
The lecture will be finalized with a short written examination. about 50% of points have to be reached to pass.

Repeat Examination:

(Recommended) Prerequisites:

Content:
The class provides the theoretical background complementing the conservation genetic lab. This class covers the theory of laboratory procedures that are trained during the lab and the computer based analysis of results. The class will focus on Genotyping using Microsatellites for plants or animals and their population genetic analysis as well as the basics for Next Generation Sequencing Analysis.

Intended Learning Outcomes:
Knowledge of theoretical background to interpret procedures and analyses of the lab class

Teaching and Learning Methods:
Lab class lecture

Media:

Reading List:

Responsible for Module:
Harald Meimberg

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

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

Module Description

CS0192: Accounting | Accounting

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	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 of the students success consists of a written exam (90 min). Both submodules are equally important. Students may use a non-programmable calculator and a Handelsgesetzbuch (HGB) without additional notes as helping material.
• In the exam related to financial accounting, students show that they are able to correctly conduct individual financial statements, understand consolidated financial statements and apply consolidation principles as well as understand and apply balance sheet policy and analysis. This is done by means of conducting consolidations, and by solving arithmetic problems as well as theoretical problems regarding financial statements.
• In the exam related to controlling, students show that they can apply different approaches to problem solving - based on the understanding of controlling. By means of exemplary objects from controlling the students demonstrate that they can interpret planning problems and connections between different problems and that they are able to interpret their results and apply the learnt instruments.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
None

Content:
The module on financial accounting gives an overview over basic financial accounting, focusing on regulations regarding commercial accounting in individual and consolidated financial statements. In the first part of the module, basic principles of financial accounting are introduced, dealing with general economic accounting and special financial accounting. In the second part, individual financial statements in terms of commercial law are explained and regulations for annual accounts and annual reports are discussed in detail. The third part deals with consolidated financial

statements and consolidation principles as well as corresponding postings in accounting. In the fourth part of the module, fundamentals of balance sheet policy and analysis are discussed.

The module on controlling introduces students to the basics and instruments of Controlling. It covers the following
topics:
(a) Description of controlling functions, tools of operative and strategic controlling
(b) Identification and application of key performance indicators
(c) Planning and monitoring: Operative, tactical and strategic planning and monitoring
(d) Case examples especially in business administration, environmental management and corporate social responsibility (CSR)

Intended Learning Outcomes:
The modul consists of two parts:
(1) Upon successful completion of the module on financial accounting, students are able to understand the construction of individual and consolidated financial statements and to apply the accounting regulations practically. They can read and draw up balance sheets. Students are also able to evaluate which enterprises have to put up consolidated financial statements and which subsidiaries have to be included. Furthermore, they can independently carry out different consolidations correctly.
(2) After participating in this introductory module on controlling, students will be able to remember and understand the basic concepts, tasks and conception of controlling systems and coordination systems, to analyze problems concerning the coordination of planning and control in management systems and to apply the newly acquired knowledge to solve these problems.

Teaching and Learning Methods:
The financial accounting module consists of a lecture and a corresponding exercise, which is integrated into the lecture. In the exercise the content of the lecture and its understanding is deepened and extended by exercises and case studies. The lectures content is conveyed by means of presentation, while in the tutorial parts students can practise how to apply theoretical concepts practically.

The controlling module consists of lectures, exercises and tutorials. During the lectures, the contents are delivered by presentations and discussions. The lectures are used to convey the theoretical. In the exercises, students apply the acquired knowledge in solving exercises and implementing case studies. Students deepen their understanding through working in small student groups as well as solving exercises on their own.

Media:
Presentations, text books, lecture notes, exercises, lecture notes

Reading List:
Buchholz, Rainer: Grundzüge des Jahresabschlusses nach HGB und IFRS, 7. Aufl., München 2011
Meyer, Klaus: Bilanzierung nach Handels- und Steuerrecht, 22. Auflage, Herne 201
Einführung in das Controlling, Weber/Schäffer, Schäffer-Poeschel, 13. Auflage;
Controlling, Horvàth, Vahlen Verlag, 13. Auflage;
Globales Life Cycle Controlling, Stibbe, Springer Gabler Verlag, 1. Auflage;
Corporate Social Responibility und wirtschaftliches Handeln, Bruton, Erich Schmidt Verlag, 1. Auflage

Responsible for Module:
Prof. Alexander Hübner Prof. Hubert Röder

Courses (Type of course, Weekly hours per semester), Instructor:
Financial Accounting (Vorlesung, 2 SWS)
David G

Controlling (Vorlesung) (Vorlesung, 2 SWS)
Röder H [L], Pokholkova M, Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0193: Foundations of Sustainable, Entrepreneurial & Ethical Business | Foundations of Sustainable, Entrepreneurial & Ethical Business

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 performance will be in the form of a written exam (120 minutes). The written exam provides a comprehensive assessment of whether students know and understand the basic principles of entrepreneurship and sustainability. They answer questions about the concepts that explain the mindset of entrepreneurial individuals and the management of entrepreneurial firms. They also answer questions about basic definitions of specific types of entrepreneurship and entrepreneurial behavior related to environmental and social problems. In addition, students will be assessed on their knowledge of basic principles and models of ethical economic behavior and their ability to use and develop knowledge of entrepreneurship. They answer questions on basic definitions and theories of ethical behavior and evaluate ethical behavior in an economic context.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The module introduces students into basic principles of the topic of entrepreneurship from a global and sustainability perspective. Students will be equipped with basic knowledge on:
- definitions, regional aspects, and special forms of entrepreneurship
- understanding of ecological and social problems and entrepreneurial approaches to solving them
- entrepreneurial individuals, including their personality, creativity, idea development, cognition, opportunity recognition, decision making, affect, and moving forward from failure
- entrepreneurial firms, including their growth strategies, strategic alliances, and resources.

Beyond that, students will engage in break-out group workshops to personally experience the process of opportunity recognition and development. In these workshops, teams apply concepts from the academic literature to real-world business issues to solve environmental and/or social problems. Furthermore, students give presentations to the audience and discuss their results.
In addition, the module introduces basic problems, arguments, and theoretical approaches of business ethics. It investigates the chances of realizing moral norms at the interception of entrepreneurship/economics and ethics. Basic is the analysis of ethical decision processes in corporations and the detailed investigation of situations and alternatives of action. Topics involve reputation, trust and social capital as well as corruption, environmental protection, and global ethical concepts. This part ends with a critical discussion of different research approaches in the debate on business ethics.

Intended Learning Outcomes:
Students know basic concepts of entrepreneurship and sustainability including basic definitions, psychological processes and characteristics of entrepreneurs as well as possible development paths of entrepreneurial firms and are able to explain them. Furthermore, students transform and apply this knowledge to real cases. They are able to find entrepreneurial solutions for ecological and/or social problems in real cases, taking into account the theories of entrepreneurial processes.

Furthermore, students understand the ethical significance of economic theories, reflect on ethical aspects in economics and apply ethical theories in an economic, social and ecological context. Students are able to draw conclusions from the known theories and concepts and to behave ethically in everyday business life.

Teaching and Learning Methods:
The module combines several learning methods.
- The basic knowledge as well as real world examples will be provided through the lecture.
- Discussions in the lecture and active participation are encouraged and will contribute to deepen the understanding of the concepts introduced.
- Workshops in smaller groups enable the students to apply (part of) their theoretical knowledge to real-world problems. This format additionally fosters creativity and team work.
- Students will get additional background knowledge from the scientific literature in private reading.

Media:
Presentations and PowerPoint slides

Reading List:
Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2010). Entrepreneurship (8th ed.). New York: McGraw-Hill.
Read, S., Sarasvathy, S., Dew, N., Wiltbank, R. & Ohlsson, A.-V. (2010). Effectual Entrepreneurship. New York: Routledge Chapman & Hall.
Lütge, C., Uhl, M. (2018). Wirtschaftsethik. München: Vahlen.
Crane, A., Matten, D., Glozer, S., Spence, L. (2019): Business Ethics. Oxford: Oxford University Press

Responsible for Module:
Prof. Claudia Doblinger

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Entrepreneurship (Vorlesung, 2 SWS)
Doblinger C [L], Doblinger C, Fischer D

Introduction to Business Ethics (Vorlesung, 2 SWS)
Doblinger C [L], Krinner S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0194: Mathematics | Mathematics

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Learning outcomes shall be verified in a written test (90 min). Tasks shall be specified by means of which the students are to demonstrate that they know the mathematical methods imparted as part of the module and that they have understood and are able to apply them for specific case studies.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge in mathematics corresponding to basic knowledge of A-level students.

Content:
Selected mathematical methods required for calculations in the scientific, engineering, and economic areas, as well as areas of sustainability, including analysis (e.g. mathematical induction, differential and integral calculus, sequences and series), calculations with real and complex numbers as well as selected chapters of linear algebra (e.g. linear equation systems, matrices, inverse matrices, determinant, eigenvalues and eigenvectors). The methods are introduced in the lecture. In the exercises, their application is practiced on concrete case studies, including examples with relevance to sustainability.

Intended Learning Outcomes:
The students know the most important mathematical methods required for calculations in the scientific, engineering, and economic field, as well as areas of sustainability. They have understood these methods and are able to calculate specific case studies and perform basic mathematical proof by means of complete induction.

Teaching and Learning Methods:
Lecture, presentation, and associated exercises with independent processing and teamwork of specific examples. Mathematical methods shall be presented during the lecture. Within the scope of the exercise, their application shall be practiced based on specific case studies.

Media:
Digital presentation, writing on the board, exercise sheets

Reading List:
Calculus and Linear Algebra in Recipes. Christian Karpfinger, Springer-Verlag 2022

Responsible for Module:
Grimm, Dominik; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Mathematics (Exercise) (Übung, 2 SWS)
Grimm D [L], Grimm D

Mathematics (Lecture) (Vorlesung, 2 SWS)
Grimm D [L], Grimm D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0195: Applications in Sustainable Management and Technology | Applications in Sustainable Management and Technology [Applic. in SMT]

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**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:
The students work together in teams and deal with a specific question from practice. For this purpose, the students explain the current state of science and describe the specifics of their own research work. They also formulate the procedure for dealing with their practical problem and outline the solution steps. The results are documented in a written project work.

Repeat Examination:

(Recommended) Prerequisites:
None

Content:
The course conveys skills to develop solutions to specific problems in real business in case studies in the area of sustainability and enterprise planning. These relate to topics such as performance evaluation of supply chains, controlling, human resource or other functions.

Intended Learning Outcomes:
At the end of the module, students are able to understand basic and advanced problems of sustainable management and technologies. The intended learning outcomes of this course are to be able (1) to obtain insights from practice,
(2) understand the motivation and barriers of sustainability within a business context, (3) learn to assess appropriate approaches to solve a sustainability issue in practice and (4) to communicate and discuss solutions in spoken and written language.

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Module Description

CS0196: Sustainable Operations | Sustainable Operations

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 module examination consists of a written exam (90 min.). Permitted tool is a non-programmable calculator.
In the written exam, students demonstrate that they can apply various approaches to problem solving, building on their understanding of production and logistics planning in general. Using exemplary tasks from production or logistics planning, students demonstrate that they can interpret planning problems as well as relationships between different problems. Based on this, students will provide recommendations for a solution to these problems.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of Mathematics and Management Science are recommended

Content:
This is a basic module in which an overview of planning problems in production and logistics and methodologies for solving them will be developed. Students are familiarized with different levels of planning hierarchy (strategic, tactical, operational) and the planning problems at each level. Heuristics and additionally simple models of linear and mixed-integer programming are discussed and applied as methodologies for solving the planning problems in the area of production and in the area of logistics. The module includes these parts, among others:
- Strategic planning problems: e.g. location planning
- Tactical planning: designing the infrastructure of different production systems (workshop production, flow production, production centers)
- Operational planning problems: Demand forecasting models, main production program planning
- Material requirements planning

- Resource scheduling and control: lot size planning, machine scheduling planning, line-up sequences for flow production
- Transportation logistics: planning problems for determining tours, routes and packing schemes
- Material logistics: policies for inventory management and their extension to stochastic demands; strategic design of the logistics network; interfaces with predecessor or successor companies
- Procurement logistics: methods for the selection of suppliers
- Distribution logistics: setting up a suitable supply network; processes in the warehouse

Intended Learning Outcomes:
After participating in this basic module, students are able to understand interrelationships between various planning problems in production and logistics. Analyze selected planning problems of the strategic, tactical and operational level (for details see learning content) and apply potential solutions to manage them. In doing so, the students know essential management tasks in production and logistics planning and learn to evaluate the economic and sustainability-relevant significance of production and logistics-related decisions (e.g. the trade-off between inventory and setup costs or between costs, service and environmental protection).

Teaching and Learning Methods:
The learning methods include lectures, tutorials and in-depth literature. The lectures serve to teach theoretical basics including the completion of exercises. The tutorials accompanying the lectures deepen the contents of the lectures in smaller groups and include calculation of exercises mainly in individual work, partly also in group work. Literature for in-depth study will be announced and recommended in the lecture.

Media:
Presentations, Script

Reading List:
Günther, H.O., Tempelmeier, H. (2020), Supply Chain Analytics
Ghiani, G., Laporte, G., Musmanno R. (2013), Introduction to Logistics Systems Management, 2. Aufl., Wiley

Responsible for Module:
Prof. Alexander Hübner

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

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

Module Description

CS0197: Sustainable Investment and Financial Management | Sustainable Investment and Financial Management

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**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 grading is based on a written exam with a duration of 120 minutes. To test whether the students acquired the theoretical basics in financial analysis and investment planning, questions are asked, where they have to prove their understanding of the introduced concepts. By using a calculator, the students for example have to analyze investment projects, create the optimal capital structure of projects or firms, evaluate bonds, stocks, or sustainability of investments.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
The module will give students a broad understanding of the instruments to analyze and evaluate investment opportunities such as:
- Financial Statement Analysis (balance sheet analysis, analysis of profit and loss account, statement of affairs)
- Investment Analysis (net present value method, actuarial return)
- Capital Budgeting (determination of free cashflows, choosing between alternatives)
- Cost of Capital (equity costs, borrowing costs, capital costs)
- Capital Structure

Furthermore, the students will be introduced to sustainability concepts in financial management such as social responsible investing, developments in finance and sustainability and ESG (Environment, Social, Governance) criteria for investments.

Intended Learning Outcomes:
Upon completion of this module students will be able to: (1) to name and apply important measures of company performance, (2) to analyze and choose investment projects, (3) to create the optimal capital structure of projects and firms, (4) restate and employ concepts of financial mathematics and (5) to evaluate financial instruments. The students will be trained in these methods by applications to sustainable financial management and discuss e.g., green investments. The course will prepare participants to understand major drivers and constraints of transforming the financial system to a more sustainable one. Furthermore, it will familiarize participants with the business, regulatory and technical perspective of sustainable finance and will acquaint them to take an active part in the discussion around the topic.

Teaching and Learning Methods:
The module will combine several teaching methods.
- Weekly Lecture: Presentation of theoretical basics and applied examples, supported by slides. As a better learning effect is reached by a dynamic learning environment, the student can join in live surveys with onlineTED.
- Exercise available on several dates: Calculation of selected exercises from the set of exercises in small groups so the students can directly ask questions about the calculations.
- Set of exercises with applied examples for individual practising of exercises.

Media:
Presentations, exercises with solutions

Reading List:
Berk/DeMarzo (2020), Corporate Finance, 3rd. Edition, Pearson.
Schoenmaker, D (2020): Principles of Sustainable Finance
Thompson (2021): Principles and Practice of Green Finance: Making the Financial System Sustainable

Responsible for Module:
Prof. Alexander Hübner

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

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

Module Description

CS0198: Green Marketing and Innovation Management | Green Marketing and Innovation Management

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**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 grading will be based on a written exam (120 min). By answering multiple choice questions students have to show that they have understood and can apply models and concepts related to markets aspects of innovation and to the organization of the innovation process. The questions also assess whether students remember and understand green marketing basics (including key terms, theories, frameworks, the use of marketing strategies and marketing mix instruments, and their interrelationship with core concepts in marketing). The questions may require calculations. Students may use a nonprogrammable calculator to do these calculations. Bonus points can be gained by participating in the optional course group work.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
Market aspects of innovation:
Innovation: Examples and particularities,
Innovation and the development of industries,
Sources of innovation,
Innovation strategy: Analysis of the market, technology and competition,
Acquisition of technology: Market, cooperation and networks

Organizing the innovation process:
The innovation process within the firm,
R&D, production and marketing,

Cooperation for innovation?
Motivation and incentive systems,
Promotors and champions,
Roles in the innovation process,
Opposition against innovation within the firm,
Integrating customers into the innovation process,
Measuring and controlling innovation.

Marketing Management:
Principles of marketing,
Marketing strategy and environment in green business environments,
Creating customer value, satisfaction, and loyalty in green markets,
Information management and market research,
Analyzing green consumer and business markets,
Competition and differentiation from competitors,
Segmenting, targeting, and positioning,
Creating and managing products and services, brand management,
Pricing,
Marketing communications,
Marketing channels,
Services

Intended Learning Outcomes:
At the end of the module, students will be able to (1) recognize and apply models and concepts related to the market aspects of innovation (e.g., modes of acquisition of technology) and to the organization of the innovation process (e.g., promotors and champions in the innovation process), (2) identify how they can be concretely used in companies and in the context of green innovation, (3) remember and understand the key terms used in green marketing, (4) explain common marketing theories and frameworks in this context, (5) describe and justify the use of both marketing strategies and marketing mix instruments, and (6) relate the strategies and use of instruments to core concepts in marketing, such as customer lifetime value, segmenting, targeting, and positioning, decision making styles, customerperceived value, satisfaction, and loyalty, as well as branding in the context of green marketing.

Teaching and Learning Methods:
The module consists of two lectures including one or two sessions held by guest speakers to refer to state of the art examples of green marketing and innovation. Students will be motivated to read the literature before and after each lecture and relate it to the content taught in class. Furthermore, they will be motivated to discuss the content in online forums that are made available to the students.

Learning activities: Literature research, (optional) group project

Media:
Lecture slides are available via Moodle. Presentation slides, online discussion forum

Reading List:
Afuah Innovation Management. strategies, implementation, and profits
Dodgson, Gann, Salter The Management of Technological Innovation (Chapter 4)
Teece Profiting from Technological Innovation: Implications for integration, collaboration, licensing and public policy
Stamm Structured Processes for Developing New Products
Hauschildt, Kirchmann Teamwork for innovation the ""troika"" of promotors
Kotler/Keller/Brady/Goldman/Hansen (2016): Marketing Management, 3nd European ed., Pearson: Harlow.
Kotler/Armstrong (2018): Principles of Marketing, 17th ed., Pearson: Harlow.
Homburg (2017): Marketingmanagement. Strategie – Instrumente – Umsetzung – Unternehmensführung, 6. Aufl., Gabler: Wiesbaden.

Responsible for Module:
Prof. Klaus Menrad

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

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

Module Description

CS0199: Statistics | Statistics

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Learning outcomes are verified in a written exam. The exam consists of assignments in which the students are to demonstrate that they understand the statistical methods conveyed as part of the module and are able to apply them to specific examples. Exam duration: 90 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Qualification for university entrance; good mathematical knowledge is an advantage.

Content:
Selected statistical methods required in natural sciences, engineering, or economics, especially from the fields of descriptive statistics (e.g., graphical representation of uni- and bivariate data, measures of location and spread, measures of association for bivariate data, descriptive linear regression), probability calculus, and statistical inference (e.g., confidence intervals, hypothesis tests). The methods are presented during the lecture and are applied to specific examples related to sustainability in the exercise classes.

Intended Learning Outcomes:
The students know the most important statistical methods required in natural sciences, engineering, or economics. They have understood these methods, are able to select and perform suitable statistical procedures for specific case studies, and can draw correct conclusions from the results. Furthermore, the students should be aware of the capabilities and limitations of the presented statistical methods and are able to perform simple statistical analyses using statistical software (e.g., R).

Teaching and Learning Methods:
Lecture using digital presentation and/or blackboard to convey contents and methods. In addition, concrete examples are discussed in the exercise classes through independent work or group work.

Media:
Slides, blackboard, exercise sheets, e-learning

Reading List:
Diez, Cetinkaya-Rundel, Barr: OpenIntro Statistics, 4th edition, https://www.openintro.org/book/os/ (2019).
Fahrmeir, Heumann, Künstler, Pigeot, Tutz: Statistik - Der Weg zur Datenanalyse, 8. Auflage, Springer Spektrum (2016).
Field, Miles, Field: Discovering Statistics Using R, SAGE Publications (2012)
Caputo, Fahrmeir, Künstler, Lang, Pigeot, Tutz: Arbeitsbuch Statistik, 5. Auflage, Springer Verlag (2009).

Responsible for Module:
Thielen, Clemens; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Statistics (Lecture) (Vorlesung, 2 SWS)
Thielen C [L], Thielen C

Statistics (Exercise) (Übung, 2 SWS)
Thielen C [L], Thielen C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0200: Strategic and International Management & Organizational Behavior | Strategic and International Management & Organizational Behavior

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 is provided in the form of a written, graded written exam (120 min). The written exam consists of single-choice questions that test knowledge at different levels: Knowledge questions test recall and reproduction of learned concepts, e.g. by reproducing different change management models; Decision questions test the classification or interpretation of learned content, e.g. by contrasting and comparatively analyzing different strategies of internationally active companies; Application and scenario questions test whether students can apply the content learned in the lectures to practical problems and challenges, e.g. by developing proposed solutions in the context of a case description on the topic of conflict management. The overall grade will be determined through the performance in the written examination. Students are permitted to use a non-electronic dictionary (English - Native Language or English Thesaurus) during the exam. Beyond that, no aids such as lecture notes, personal notes, etc. are allowed. There will be mid-term evaluations that may be included in the exam grade by 0.3.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basics in Management

Content:
In accordance with the learning outcomes formulated above, the most important theories and methods of industrial and organizational psychology as well as strategic and international management are covered. Basic approaches and models of industrial and organizational psychology are used to understand the behavior of individual organizational members, teams and entire organizations. In addition, as globalization increases, companies in almost all industries

and of all sizes are operating internationally and must incorporate this reality into their strategic considerations. Not only is knowledge of international management necessary in the management of companies operating across borders, but the international dimension must also be taken into account in individual business functions. Therefore, a special focus is placed on the international dimension of the concepts to be dealt with. In detail, the following aspects will be addressed and made theoretically and practically useful: basics of employee management; basics and characteristics of strategic and international management; framework conditions of strategic and international management; effects of individual personality traits and motivation in organizations; ethical and moral behavior in organizations; structures and processes in work teams; change management in national and international organizations; theories of international corporate activity; strategies of internationally active companies; international dimension of individual business management functions; organizational culture in national and international comparison.

Intended Learning Outcomes:
After successful participation in the module, students will be able to understand and explain key concepts of industrial and organizational psychology as well as strategic and international management. In addition, students will be able to apply the gained knowledge to practical challenges and problems. Students will be able to identify and analyze challenges and problems in the areas of employee motivation, teamwork, decision-making behavior and communication with a special focus on international companies. Ultimately, they will be able to identify and demonstrate practical solutions to conflict management, change management, ethical problems and challenges in strategic and international management by applying the theoretical concepts learned.

Teaching and Learning Methods:
In the interactive lectures, the most important concepts, approaches and theories as well as their empirical evidence are taught and critically discussed with the students. The theoretical and methodological lecture contents are illustrated by examples and case studies and applied to practical problems. In addition, students are encouraged to engage intensively with the content and transfer the theories and methods covered through the analysis of instructional videos as well as individual assignments and/or work in small groups. Finally, the (self-) study of literature is planned.

Media:
Presentations (slides as download)
Vid

Responsible for Module:
Prof. Claudia Doblinger

Courses (Type of course, Weekly hours per semester), Instructor:
Strategic and International Management (Vorlesung, 2 SWS)
Doblinger C [L], Doblinger C, Krinner S

Organizational Behavior (WI001121) am Campus Straubing (Vorlesung, 2 SWS)
Goerg S [L], Benzinger D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0201: Fluid Mechanics | Strömungsmechanik

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 module will be assessed by a written examination. Students calculate tasks of fluidmechanics based on its fundamental equations. In addition, the unterstanding of content is tested by the explanation of theoretical operations. Dimensionless numbers to evaluate complex task are applied and explained. Altogether the students show that they can solve known tasks from the fluid mechanics area and transfer their acquired knowledge to new assignments of tasks.
Exam duration: 90 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of the most important physical correlations (basic parameters with units, definition of pressure, temperature etc.) must be available. Besides formation and solution of systems of equations as well as command of simple integral and differential calculus as well as Physics and Mathematics is a requirement.

Content:
This module provides basics of fluid mechanics, that are relevant for further engineering applications . Therefore the theoretical fundamentals are derived and deepened throug illustrating examples . The content will cover the following topics: hydrostatics, fluid dynamics (Bernoulli , Navier-Stokes , flow resistance), CFD.

Intended Learning Outcomes:
After participating in the module, students are able to understand and analyze simple tasks regarding flows, to apply the methods for their solution and to give a mathematical solution. In particular the students can transfer the learned methodology and the obtained results to new assignments of tasks.

Teaching and Learning Methods:
The module consists of a lecture during which also exercises will be performed alternately. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Presentations, slide scripts, exercises

Reading List:
Siekmann, Thamsen: Strömungslehre, 2. Auflage, Springer
Örtel: Strömungsmechanik für Ingenieure und Naturwissenschaftler, 7. Auflage, Springer
[226] Baehr, Hans Dieter; Kabelac, Stephan: Thermodynamik, 14. Auflage, Springer, ISBN 978-3-642-00555-8, 2009
[242] VDI Wärmeatlas, VDI-Gesellschaft Verfahrenstechnik und Chemie-Ingenieurwesen 9.Auflage, Springer-Verlag ISBN 3-540-41201-8 9.Auflage

Responsible for Module:
Prof. Matthias Gaderer

Courses (Type of course, Weekly hours per semester), Instructor:
Strömungsmechanik (Vorlesung) (Vorlesung, 2 SWS)
Gaderer M [L], Huber B

Strömungsmechanik (Übung) (Übung, 2 SWS)
Gaderer M [L], Huber B
For further information in this module, please click campus.tum.de or here.

Module Description

CS0202: Empirical Research Methods | Empirical Research Methods

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Grading is based on a 100% multipe-choice exam (120 minutes) with about 50-60 questions at the end of the lecture. The questions will be of different character and allow students to show that they have understood basic concepts of empirical research and that they can analyze and evaluate research design and research outputs on their empirical and conceptual accuracy

Extra credit (Mid term assignment)
Accompanying this class, you will be able to participate in two types of work to earn extra credit toward your grade. This means that completing this work is not mandatory, and full marks can be achieved without participating. The first assignment is a teamwork task and focuses on the comprehension of a chosen empricial paper on either a problem form the management or policy literature. Each student has to write a short summary (1-2 pages). The second assignment is an individual task and is about the systematic creation and processing of a data set. The workload for this task is on average about 4-6 hours. Both extra assignments help to improve class performance and can improve the final grade. Participating successfully in these assignments may improve the final grade by 0,3.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Mathematics, Statistics

Content:
This course aims to enable students to understand empirical research. The course explains how research works and how to identify sources that meet a certain level of academic rigor to be trustworthy. This is important as only trustworthy information should become a source of learning and a foundation of managerial or political decision making.

To reach this goal the course will cover the following topics:
• Research ethics
• Research question and their implications
• Paper reading, positioning, and contributions
• Correlation and causality
• Choosing a research design
• Qualitative research
• Quantitative analysys & quantitative research design
• Using existing scales and data
• Data preparation and descriptive statistics
• Advanced quants

Intended Learning Outcomes:
This module will give you an introduction to empirical research methods, including the higher aims of empirical research, the standards it needs to meet, and a set of methods that you can directly apply. By the end of the module, you will thus be able to understand the scientific proces. They will be able to evaluate whether a result or statement is robust and indeed trustworthy. In doing so, not only will they be able to more critically evaluate everyday information, but they will also be prepared to participate in the scientific process. Students improving their ability to read and understand academic work. This modile prepares for future research seminars or the final thesis.

Knowledge Objectives
After the module students will be able to:
• understand the nature of the scientific process
• explore different approaches toward solving (scientific) problems
• use and apply selected empirical research methods (e.g., for seminar of final theses)
• understand the structure and evaluate the quality of academic papers
• (in parts) create their own research projects

Skills Objectives
• improve diagnostic and analytical skills
• think creatively about how best to solve complex problems
• build up critical thinking as well as judgment and interpretation skills
• learn how to evaluate different strategic options
• work together efficiently and effectively in groups

Learning Objectives
At the end of this module, students will be able to demonstrate understanding, critical assessment and application of the following:
• assess (pseudo-)scientific work
• understand and evaluate potential approaches toward answering academic questions
• utilize tools and techniques of empirical research for their own future studies

Teaching and Learning Methods:
The module consists of lectures and excersises. The lecture is based on slides and blackboard utilizing additional interactive elements. In the exersice, which takes place in the computer pool, students work on their own with data and learn how to utilize different software packages. Students will be very involved in the excersises and deepen their understand of the topics covered in the lectures.

Media:
Powerpoint, Board, Videos, Flipchart, Debates

Reading List:
For each session, practice-sheets will be provided. These sheets will also contain information on reading materials that elaborate on what we cover in class. We recommend the following textbooks (on which we will also draw to some degree for the lecture):
• Singleton, R. A., Straits, B. C., & Straits M. M.1993 (or newer). Approaches to Social Research (≥2nd ed.). Oxford University Press. (Abbreviated “ASR” in preparation sheets)
• In German: Backhaus, K., Erichson, B., Plinke, W., & Weiber, R. 2010 (or newer). Multivariate Analyse¬methoden: Eine anwendungsorientierte Einführung (≥13th ed.). Berlin: Springer.
• Salkind, N.J. 2008 (or newer)). Statistics for people who think they hate statistics (≥ 3rd ed.). Thousand Oaks, CA: Sage.
• Hair, J. F., Jr., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. 2005 (or newer. Multivariate data analysis (≥6th ed.). Upper Saddle River, NJ: Prentice Hall.

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

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

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

Module Description

CS0203: Communication Skills | Communication Skills

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Students can choose between a number of courses addressing different communicative challenges. The examination is not graded (Studienleistung) and can be an oral assessment or a written exam. Please find detailed information regarding course examinations, content, learning outcomes, literature and teaching and learning methods in the individual course description (Lehrveranstaltungsbeschreibung) in TUMonline.

For example:
The oral assessment or presentation assess students' ability to transport their point of view in a comprehensible and well-structured manner. Students show that they can communicate scientific or business issues in a careful but effective way. They communicatively create a situation of mutuality independent of culture-specific particularities. Answering questions students show that they can advocate their angle on a topic using communication methods.

A list of up-to-date information in which courses students may earn credits will be provided by the program management (Studienkoordination) at the beginning of the semester.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Students can choose between a number of courses addressing different communicative challenges:

(1) Presentation & Moderation Techniques:

- use and effect of voice, language and body language
- managing the impact on employees and customers
- defining explicit goals and objectives
- responsibilities, role and self-perception of an facilitator
- strategies how to conduct a fruitful discussion

(2) Conflict Management & Conduct of Negotiations
- conflict types
- causes and development of conflicts
- systematic conflict analysis (e.g. stages of escalation after Glasl)
- conflict patterns
- concepts of negotiation strategies,
- conflict de-escalation

(3) Business Plan
- developing a business plan
- assessment of business ideas
- analyzing market & competition
- pitching business idea

(4) Intercultural Communication
- share information across different cultures and social groups
- interact with people from other cultures
- understand customs from people of different countries

(5) Language Courses
(offered by TUM Language Center or courses completed abroad equivalent to 3 ECTS)
- learn a foreign language
- be more open to another culture
- assessment of business ideas; analysing market & competition

Intended Learning Outcomes:
Upon successful completion of the module students are able to (1) efficiently and appropriately communicate business and scientific topics to others such as employees or an audience. (2) They are able to present and discuss complex issues referring to a scientific basis within groups or in front of an audience and (3) lead a discussion. Furthermore, they are able to (4) tackle conflict situations and (5) manage to communicatively find a solution.

Teaching and Learning Methods:
To sharpen their communication skills the focus in these courses is to practice in different situations and settings. Depending on the selected course, students will e.g. hold short presentations, pitches or exercise in role-plays. To deepen and strengthen these learning experiences peers and instructors will give immediate feedback.

Media:
PowerPoint slides, moodle, videos, online learning materials

Reading List:
- Ant, Marc; Nimmerfroh, Maria Christina; Reinhard, Christina (2014); Effiziente Kommunikation - Theorie und Praxis am Beispiel “Die 12 Geschworenen”; Springer Gabler
- Alan Barker (2013); Improve Your Communication Skills; Kogan Page Publishers

Responsible for Module:
Prof. Alexander Hübner

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

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

Module Description

CS0204: Project Studies | Project Studies

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 12	**Total Hours:** 360	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:
The project study is a practical task which either a single student or a a team of 2-5 students work on. The students deal with a specific task of a company, agency or any other similar institution (including research projects at university chairs) and work out the state of the current research on the given issue and describe their own specific solution to the given task . Based on scientific knowledge and methodical skills, the students evolve the task. The project study is supported by a professor of the TUM Campus Straubing as well as representatives of the firm, agency, and instituion respectively. The students present the results of their study in a written term paper. Grading will especially take into account the overall working outcome of the project with respect to the initial problem set, the selection and application of the chosen methodology as well as the discussion of the main findings. In case of team work, each student’s individual contribution to the written paper and the project's success must be identifiable and assessable.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowlege in Business Administration and Economics

Content:
In the project study, students acquire hands-on experience by working with companies/institutions/agencies on a particular assignment, for example:
- sustainability analyses of single activities or projects
- the application of optimization tools for problems out of the logistic sector,
- the description of a marketing strategy.
They structure the project and employ their methods and theories to develop results of practical value for the company/institution/agency. The project is supervised jointly by mentors from the

respective partner company/agency and the professor of the TUM Campus Straubing. The project study should be accomplished in about three to six months.

Intended Learning Outcomes:
After successfully completing the module students are able to work on a project in a systematic and academic manner. In case of team work, students can contribute a significant part to the work output of their team. They accomplish their task within a given time-frame. The students can identify and express problem sets. Furthermore they can term appropriate methodologies for problem solving and transfer them to a proper solution. Finally they can choose and apply the appropriate methodologies to solve the given problem.

Teaching and Learning Methods:
Working on a solution for the given project in a team or individually encourages students to deal soundly with a practical issue. Thus, they can apply their knowledge gained in their study on real issues firms struggle with. Further, they are able both to communicate the evolvment of the project and to present the solution to the supervisors from the company/institution and the university.

Media:
literature, presentations

Reading List:
Relevant literature will be selected and communicated specifically for the project.

Responsible for Module:
Prof. Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Projektstudium | project studies (Orientierungsveranstaltung, 1 SWS)
Hübner A [L], Hübner A, Lex E
For further information in this module, please click campus.tum.de or here.

Module Description

CS0205: Bachelor's Thesis | Bachelor's Thesis

Version of module description: Gültig ab winterterm 2021/22

Module Level:	Language:	Duration:	Frequency:
Bachelor	German/English	one semester	winter/summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
12	360	360	0

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

Description of Examination Method:
The Bachelor's Thesis is a final paper with a duration of 3 months, where the students concentrate on a specific topic in business administration and economics. Here the students frame the state of research and discourse and evolves the own specific topic. Based on scientific knowledge and methodical skills, students autonomously discribe the topic. The Bachelor's Thesis is supported by a professor of the TUM School of Management.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
120 credits, including all compulsory modules from the first four semesters, according to the module plan of the respective bachelor's program

Content:
The Bachelor's Thesis focuses on a research topic in business adminstration and economics, usually at the interface to engineering and natural sciences. The Thesis is always supervised by a professor of TUM School of Management, often in co-operation with an organization of industry or research. The topic of the Thesis is created so that it can be treated extensively within three months.

Intended Learning Outcomes:
At the end of the module "Bachelor's Thesis" students are able to handle and develop a project in an autonomic, systematic and scientific way. Therefore the students deploys scientific knowledge and methodical skills to the specific subject. They script the state-of-the-art knowledge, based on research, and classify the findings within the scientific and/or practical discussion. The students are able to cope with new and complex subjects in an autonomous way.

Teaching and Learning Methods:
The creation of the thesis encourages the students to deal soundly with a scientific subject. Therefor they apply the knowledge and methodical skills, acquired during the studies, and create an elaborated scientific documentation within the set time frame.

Media:
Literature, presentations

Reading List:
specific literature based on the topic

Responsible for Module:
Prof. Alexander Hübner

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

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

Module Description

CS0206: Introduction to Environmental and Resource Economics | Introduction to Environmental and Resource Economics

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**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 will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental evaluation and resource economics using national and international examples. Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Microeconomics,Empirical Research Methods

Content:
Environmental and natural resource economics is a rapidly growing and changing field because many environmental issues are of global importance. This course teaches the theoretical concepts and empirical methods for evaluating environmental assets and ecosystem services (Total Economic Value) as well as the integration of the collected monetary values into a cost-benefit analysis for an investment decision in environmental projects, including discounting of costs and benefits.

Intended Learning Outcomes:
After attending the module, the student has an understanding of how to evaluate existing and future environmental assets and naturally occurring resources in theory and practice. Students have an awareness of the way in which ecosystem services (total economic value) can be valued monetarily if they are not traded in the market (use versus non-use values). The students then learn how such values can be used in cost-benefit analyzes of environmental projects in order to make investment decisions. By conducting a survey of the total economic value of an ecosystem

based on a given example, the students gain knowledge of where difficulties can arise in the practical implementation of the monetary valuation of environmental assets ecosystem services.

Teaching and Learning Methods:
The lecture and tutorial take place using Powerpoint. In addition, current examples of environmental assessment, articles from newspapers and scientific journals are integrated into the lectures. Using the references presented, students discuss concepts and derive hypotheses individually and/or in groups from different perspectives from the literature. In the tutorial, students are instructed to design, carry out and analyze a survey to determine the overall value of an ecosystem.

Media:
Presentations, slide scripts, scientific articles, online lecture examples

Reading List:
Pearce, D. and R.K. Turner(1990). Economics of Natural Resources and the Environment. Johns Hopkins Univ Pr.
Tietenberg, T. and L. Lewis (2008). Environmental & Natural Resource Economics. Addison Wesley; 8 edition.

Responsible for Module:
Faße, Anja; 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

CS0207: Introduction to Electrochemistry | Einführung in die Elektrochemie

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer 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:
Das Erreichen des Lernziels wird durch eine Klausur überprüft (Prüfungszeit: 60min). Auf die Note dieser schriftlichen Prüfung können bis zu 10% der Gesamtpunktzahl als Bonuspunkte angerechnet werden. Dabei legen die Ergebnisse der Onlinetests, die während des Semesters abgehalten werden, die Höhe der Bonuspunkte fest. Es müssen mindestens 65% der Punkte im Onlinetest erreicht werden, um Bonuspunkte zu erhalten. Dabei ist die Anhebung der Note von 4,3 oder schlechter auf 4,0 nicht möglich. Dies soll die Studierenden animieren kontinuierlich an den für sie sehr wichtigen Vorlesungen und Übungen teilzunehmen. Anhand von Fragen zu elektrochemischen Aspekten weisen die Studierenden nach, dass sie die entsprechenden Fachbegriffe, Bezeichnungen und Inhalte kennen, die grundlegenden Zusammenhänge verstanden haben und ihr Wissen über die ablaufenden Reaktionen im Rahmen der kinetischen und thermodynamischen Zusammenhänge anwenden können. Dazu werden konkrete rechnerische Aufgaben gestellt.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Erfolgreiche Teilnahme am Modul „Allgemeine Chemie“, „Physikalische Chemie“, „Mathematik“ und „Physik“ oder vergleichbare Kenntnisse.

Content:
- Konzepte der Elektrochemie: elektrochemische Thermodynamik (elektrochemisches Potential, Elektrodenpotential, Nernst Gleichung), Transport in Lösungen (Migration, Diffusion und Konvektion), Thermodynamik von Grenzflächen (die elektrochemische Doppelschicht), elektrochemische Kinetik.

- Aufbau einer elektrochemischen Messung und das Funktionsprinzip eines Potentiostats (Aufbau, Funktion und Anwendung).
- Stationäre Voltammetrie (Potentialsprung, lineare und zyklische Voltammetrie an Makro- und Mikroelektroden) für die Bestimmung von thermodynamischen und kinetischen Parametern.
- Mechanismen gekoppelter homogener Reaktion zur Energiekonversion und Elektrosynthese.
- Beispiele für die Anwendungen von Elektrochemie in realen Systemen (Gewinnung und Konversion erneuerbarer Energien, grüne Elektrosynthese).

Intended Learning Outcomes:
Die Studierenden erinnern das Basiswissen über fundamentale Konzepte der Elektrochemie und elektroanalytischen Chemie. Sie sind in der Lage, mit den generellen Prinzipien der Elektrochemie umzugehen und diese auf vereinfachte Probleme von realen elektrochemischen Systemen anzuwenden. Ein besonderer Fokus liegt hierbei auf dem Verständnis des allgemeinen und zeitlichen Zusammenspiels von Elektronentransfer, chemischen Reaktionen und Massentransport, welche die elektrochemische Antwort des Systems definieren. Des Weiteren sind die Studierenden vertraut mit industriell relevanten Prozessen und wie die Elektrochemie bei nachhaltiger Energiegewinnung und -speicherung helfen kann. Zusätzlich können sie die erlernte Theorie auf reale Beispiele aus Forschung und Industrie anwenden.

Teaching and Learning Methods:
In dieser Vorlesung werden die Lehrinhalte durch Vorträge des Dozenten anhand von Textdokumenten, PowerPoint-Präsentationen und Tafelbildern vermittelt. Dies ermöglicht eine detaillierte Darstellung des Lehrinhaltes und die Studierenden sind in der Lage Fragen zu stellen und zu diskutieren, sobald diese entstehen. PowerPoint Folien und Tafelbilder helfen als visuelle Unterstützung, um die komplexen Zusammenhänge in der Elektrochemie zu verstehen. Zusätzlich werden den Studierenden Übungsaufgaben zur Festigung des in der Vorlesung gelernten Inhaltes bereitgestellt. Die Lösungen dieser Übungsaufgaben werden später in einer Übungsstunde von den Studierenden präsentiert und diskutiert.

Media:
Präsentationen, Moodlekurs mit Onlinetests, Übungsblätter, Fragenkatalog, PowerPoint, Skript

Reading List:
Elektrochemie, Hamann/Vielstich, ISBN: 3527310681
Electrochemical Methods: Fundamentals and Applications; Bard/Faulkner, ISBN-13: 978-0471043720

Responsible for Module:
Prof. Nicolas Plumeré

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Elektrochemie (Übung) (Übung, 1 SWS)
Plumeré N [L], Höfer T

Einführung in die Elektrochemie (Vorlesung) (Vorlesung, 2 SWS)
Plumeré N [L], Plumeré N
For further information in this module, please click campus.tum.de or here.

Module Description

CS0208: Reaction Engineering and Fluid Separations | Chemische und Thermische Verfahrenstechnik

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 135	**Contact Hours:** 105

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

Description of Examination Method:
The learning outcomes of the students will be tested in a written exam. There will be computational tasks on reaction engineering as well as thermal separation processes and reaction engineering. Students demonstrate that they can diagram and explain kinetics in engineering reactors. They demonstrate that they can answer questions about the fundamentals of catalysis. The design and balancing of process steps and the application of basic concepts and relationships in thermal separation technology will be examined. On the basis of various tasks (including computational tasks), the ability to solve the acquired knowledge to solve basic process engineering problems (design of stirrers, tubular reactors, etc.) within a limited time is tested.
Duration of examination: 120 minutes, auxiliary means: Four A4 pages of any written / printed paper and a non-programmable pocket calculator.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of Thermodynamics (CS0065), Mixture thermodynamics and mass transfer (WZ1936), General Chemistry (WZ1922)

Content:
Reaction kinetics, catalysts, features of homogeneous and heterogeneous catalysis; chemical reaction technology: homogeneous/heterogeneous reactions, reactor forms (e.g. stirrer tanks, tube reactor, packed bed, fluidized bed), indicators for reactor types (e.g. reaction vessels, flow tube), types of reaction control (e.g. fixed, not fixed, continuous, isothermal), flow conditions, and residence time behavior in reactors, heat balance of reactors, strategies for optimizing reaction control. Introduction to fluid separation processes, design methods (calculation and graphical), single-stage and multi-stage operations, Mc-Cabe-Thiele-Construction, HTU-NTU-concept, fixed-

point construction for extraction columns, feasibility limitations of unit operations. Applications in the field of distillation, absorption, extraction, membranes, adsorption.

Intended Learning Outcomes:
After having participated in the module the students are familiar with the most important reaction types and parameters of chemical catalysis and reaction technology and are able to apply suitable reaction controls for predefined chemical reactions, to perform kinetic calculations for common reaction types as well as to calculate parameters such as residence time behavior and heat demand of reactors. Thus, they are capable of also transferring methods learned from examples to new processes. After completion of the module, the students are able to design and assess the fluid separation processes distillation, extraction, absorption and membranes based on state diagrams. In addition, the students understand the basic principles of the said separation processes and the apparatus employed in an industrial context.

Teaching and Learning Methods:
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the module, learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Supporting videos, script presentation sheets, exercise sheets

Reading List:
O. LEVENSPIEL: Chemical Reaction Engineering. 3. Auflage, John Wiley & Sons, New York (1998)
G. EMIG, E. KLEMM: Chemische Reaktionstechnik. 6. Auflage, Springer Vieweg, Berlin (2017)
SATTLER, K.: Thermische Trennverfahren: Grundlagen, Auslegung, Apparate, 3. Auflage, Wiley-VCH, Weinheim, 2002.

Responsible for Module:
Prof. Jakob Burger

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

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

Module Description

CS0209: Basics on Renewables Utilization | Grundlagen der Stofflichen Biomassenutzung

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Assessment takes a written examination (60 minutes), with students recall structure, transformation and use of different renewable resources. Students are required to answer questions using individual formulations and outline structures and reactions. In addition, sample calculations are to be worked out.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Introduction to various kinds of constituents of renewable resources: sugars, polysaccharides, fatty acids and oils, amino acids, proteins, terpenes, aromatics. Their structure, composition, distribution, characteristics, analytics and kind of added value, as well as their use will be introduced.

Intended Learning Outcomes:
After completion of the modules, students understand the chemical composition of renewable resources as well as their production and application. Using this knowledge students are able to explain the respective advantages and disadvantages as well as analyze the underlying physical, chemical and biotechnological principles of their conversion into valuable products.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations and case studies. Corresponding to the teaching content exercise sheets are

prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentation, script, examples and solutions

Reading List:
script, sample solutions for exercises

Responsible for Module:
Rühmann, Broder; 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

CS0210: Bioinformatics | Bioinformatik

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Learning outcomes shall be verified in a written test (90 minutes). Knowledge questions check the treated methods, algorithms and concepts in the field of bioinformatics and computational biology.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
CS0001 Foundations of Programming, CS0130 Grundlagen Biologie

Content:
Selected bioinformatic methods required for analyzing biological and bio-chemical data, especially from the area of biological databases (e.g. NCBI, Swissprot), algorithms for sequence alignments (e.g. Needleman-Wunsch, Smith-Waterman, ClustalW, BLAST) as well as methods for phylogenetic analysis. Methods shall be presented during the lecture. Within the scope of the exercise, their application shall be practiced based on specific case studies related to biotechnology and sustainability.

Intended Learning Outcomes:
The students know the most important bioinformatic methods and databases (e.g. NCBI, Swissprot, Needleman-Wunsch, Smith-Waterman, ClustalW, BLAST) for the analysis of biological and biochemical data. They will understand these methods and be able to select and perform appropriate bioinformatic procedures for specific case studies and real data, e.g. when working on biotechnology and sustainability projects.

Teaching and Learning Methods:
Lectures to provide the students with all necessary fundamentals of bioinformatics and its algorithms. In the exercises, the students will work on different analysis and programming tasks

and will develop basic Linux skills to conduct own analysis of biological and bio-chemical problems using bioinformatics tools and algorithms.

Media:
Slide presentation, blackboard, lecture and exercise recording, discussion forums in e-learning platforms, Exercise Sheets

Reading List:
Bioinformatik: Grundlagen, Algorithmen, Anwendungen, Rainer Merkl
Bioinformatics and Functional Genomics, Jonathan Pevsner

Responsible for Module:
Prof. Dr. Dominik Grimm

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

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

Module Description

CS0211: Supply Chain | Supply Chain [SC]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** English	**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:
The module examination consists of a written exam (60 min). Permitted tools are a non-programmable calculator.

In the written exam, students demonstrate that they can apply various approaches to problem solving, building on their understanding of production and logistics planning in general. Using exemplary tasks from production or logistics planning, students demonstrate that they can interpret planning problems as well as relationships between different problems. Based on this, students will provide recommendations for addressing these problems.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of Mathematics and Management Science are recommended

Content:
This is a basic module in which an overview of planning problems in supply chain management and methodologies for solving them is acquired. The students are familiarized with different planning problems. Heuristics and additionally simple models of linear and mixed integer programming are discussed and applied as methodologies for solving the planning problems. The module includes these parts, among others:
- Strategic planning problems: e.g., site planning.
- Tactical planning: designing the infrastructure of different production systems (workshop, flow production, production centers)
- Operational planning problems: Demand forecasting models, material requirements planning, resource utilization planning: lot-size planning and transportation logistics.

Intended Learning Outcomes:
After participating in this basic module, students will be able to understand interrelationships between various planning problems in supply chain management. Analyze selected planning problems at the strategic, tactical and operational levels (for details, see learning content) and apply solution approaches to deal with them. In doing so, the students know essential management tasks in supply chain management and learn to evaluate the importance of production and logistics-related decisions (e.g. the trade-off between inventory and setup costs).

Teaching and Learning Methods:
The learning methods consist of lectures, tutorials and in-depth literature. The lectures serve to explain the theoretical basics including the processing of exercises. The tutorials which accompany the lectures deepen the contents of the lectures in smaller groups and include calculation of exercises mainly in individual work, occasionally also in group work. Literature for in-depth study will be announced and recommended in the lecture.

Media:
Presentation, script

Reading List:
Günther, H.O., Tempelmeier, H. (2020), Supply Chain Analytics
Ghiani, G., Laporte, G., Musmanno R. (2013), Introduction to Logistics Systems Management, 2. Aufl., Wiley

Responsible for Module:
Hübner, Alexander; Prof. Dr. rer. pol.

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

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

Module Description

CS0212: Entrepreneurship | Entrepreneurship

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The examination consists of a 60-minute written exam.
The written exam provides a comprehensive assessment of whether students know and understand the basic principles of entrepreneurship and sustainability. They answer questions about the concepts that explain the mindset of entrepreneurial individuals and the management of entrepreneurial firms. They also answer questions about basic definitions of specific types of entrepreneurship and entrepreneurial behavior related to environmental and social problems.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
This module is an introductory module for bioeconomy and business administration. The module introduces students to the basics of the topic of Entrepreneurship.

Students will be equiped with basic knowledge on:
(1) Definitions, regional aspects, and special forms of entrepreneurship and sustainability
(2) Entrepreneurial individuals, including their personality, creativity, idea development, cognition, opportunity recognition, decision making, affect, and moving forward from failure
(3) Entrepreneurial firms, including their growth strategies, strategic alliances, and resources.

Students will further engage in break-out group workshops to personally experience the process of opportunity recognition and development. In these workshops, teams apply concepts from the academic literature to real-world business issues to solve environmental and/or social problems. Furthermore, students give presentations to the audience and discuss their results.

Intended Learning Outcomes:
After participating in this introductory module, students will be able to:
(1) explain basic concepts of entrepreneurship and sustainability including basic definitions, psychological processes and characteristics of the person of the entrepreneur
(2) identify and explain potential development paths of young firms
(3) transfer basic knowledge to real world cases. Thus, students will be able to solve entrepreneurial problems in real world settings drawing on theoretical frameworks of the entrepreneurial process.

Teaching and Learning Methods:
The module consists of one lecture, which combines several learning methods. The basic knowledge as well as real world examples will be provided through the lecture. Discussions in the lecture and active participation are encouraged and will contribute to deepen the understanding of the concepts introduced. Workshops in smaller groups enable the students to apply (part of) their theoretical knowledge to real-world problems. This format additionally fosters creativity and team work. Students will gain additional background knowledge from the scientific literature in private reading.

Media:
PowerPoint, films, internet, newspaper articles

Reading List:
Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2010). Entrepreneurship (8th ed.). New York: McGraw-Hill.
Read, S., Sarasvathy, S., Dew, N., Wiltbank, R. & Ohlsson, A.-V. (2010). Effectual Entrepreneurship. New York: Routledge Chapman &
Hall.

Responsible for Module:
Doblinger, Claudia; Prof. Dr. rer. pol. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Entrepreneurship (Vorlesung, 2 SWS)
Doblinger C [L], Doblinger C, Fischer D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0213: Environmental Resources in a Changing World | Environmental Resources in a Changing World

Resource availability, dependency and sustainable usage

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor	**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:
Students demonstrate their knowledge and understanding of the relevance of environmental resources, their limited availability, and approaches for a sustainable usage of resources in form of a written examination (90 minutes). Students deliver definitions, describe and outline relevant processes for selected environmental resources regarding their formation, utilization, supply, and sustainable use.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge and/or interest in Geology and Physics are valuable.

Content:
The course focuses on the different areas of life in which environmental resources play a critical role, such as drinking and irrigation water supply, energy provision, strategic mineral use, or sand as a building material. Thereby, an introduction to relevant expert knowledge such as formation, deposition, and utilization of relevant resources will be made. After understanding the formation of resources, their availability under current and future use in a changing environment can be assessed with special consideration of current and future demand on the resource production/ provision.

Intended Learning Outcomes:
After successful completion of the module, students understand the ecological and economic value of different environmental resources, the dependency on these resources, and the pressure

upon these resources through a changing world, such as climate and societal changes. Students comprehend the assessment of consequences of unsustainable resource use.

Students prepare short, practice-oriented tasks individually or in a project team (group work). Thereby, they acquire the ability to view and assess information within a limited period of time and solve practice-oriented questions. The edited information and results are shared with the other participants accordingly with a focus on the successful summary, presentation, and discussion of results.

Teaching and Learning Methods:
The content is taught in lectures and presentations. In addition, case studies and exercises will be discussed. Students should be encouraged to individual literature study and discussions on the theme.

Media:
Lecture, Power Point presentation, blackboard, case examples, topics prepared by participants, and round-table discussions.

Reading List:
H. Hettiarachchi & R. Ardakanian (eds.), 2016: Environmental Resource Management and the Nexus Approach. Managing Water, Soil, and Waste in the Context of Global Change. Springer, Cham.

Dassargues, A. (2018): Hydrogeology: Groundwater Science and Engineering, CRC Press, 1st edition.

Grotzinger, T. & Jordan, T. (2014): Understanding Earth. W.H. Freeman & Company, 7th edition

Responsible for Module:
Vienken, Thomas; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Environmental Resources in a Changing World (Vorlesung mit integrierten Übungen, 4 SWS)
Vienken T [L], Vienken T
For further information in this module, please click campus.tum.de or here.

Module Description

CS0214: Energy Technology | Energietechnik

Version of module description: Gültig ab summerterm 2021

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 90	**Contact Hours:** 150

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

Description of Examination Method:
Exam achievement shall be done in the form of a written test. The students demonstrate that they are able to solve computational tasks of electricity and heat generation relating to energy technology. It shall be proven that the students have understood the principles of thermal energy conversion. Type of exam: In writing, Exam duration: 180 minutes; auxiliary means: calculator

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Modules Physics (WZ1600), Mathematics 1 (CS0175), Fundamentals of Thermodynamics (CS0065)

Content:
In the module, the fundamentals of technical thermodynamics and thermal and decentralised energy technology are taught above all. The focus is on compressors, turbines, circuits for power processes, fuels, calorific value, the combustion of solid fuels, centralised and decentralised power plant technology as well as combined heat and power, refrigeration technology and solar thermal systems.

Intended Learning Outcomes:
After participating in the module, students are able to explain the basics of technical thermodynamics and thermal energy technology as well as the function and use of the different techniques. They can apply basic equations and perform them for energy balancing.

Teaching and Learning Methods:

Module Description

CS0215: Practical Course Organic Chemistry | Praktikum Organische Chemie [OCP]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Die Leistung wird in Form eines Protokolls in Form des Laborjournals erbracht. Pro Experiment sollen handschriftlich etwa zwei Seiten, welche Versuchsdurchführung und Auswertungen enthalten, angefertigt werden. Zusätzlich soll zu einem bis zwei ausgewählten Versuchen ein etwa dreiseitiges Protokoll am PC erstellt werden. Dafür müssen die experimentell erhaltenen Daten analysiert werden.
Bei geeigneter Deckung mit den in Musterversuchen erhaltenen Werten und einer ausreichenden Analyse der erhaltenen Werte sowie einer korrekten Beschreibung des Versuchsaufbaus gilt das Praktikum als bestanden.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundlagen organische Chemie, anorganische Chemie

Content:
Rückflusskochen, Kristallisieren, Destillieren, Abnutschen, Ausschütteln mit nicht mischbaren organischen Lösungsmitteln, Dünnschichtchromatographie, Säulenchromatographie

Intended Learning Outcomes:
Die Studierenden haben praktische Fähigkeiten zur Durchführung organisch chemischer Reaktionen erworben. Anhand einfacher Reaktionen wurden die typischen Handgriffe organisch-chemischen Arbeitens erlernt. Die Studenten können nach Abschluss des Praktikums einen Versuch korrekt vorbereiten und aufbauen, durchführen, protokollieren, das erhaltene Ergebnis analysieren, sowie mögliche Ursachen von Fehlwerten erkennen.

Teaching and Learning Methods:
Durch eigenes Experimentieren der Studierenden unter Anleitung werden Handhabung von Chemikalien und Geräten eingeübt, dadurch werden manuelle Fähigkeiten und experimentelles Geschick erworben. Es werden ca. 10 Versuche durchgeführt.

Media:
Praktikumslabor

Reading List:
H.G. Becker, Organikum, 21. Aufl., Wiley VCH

Responsible for Module:
Prof. Nicolas Plumeré

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

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

Module Description

CS0215: Practical Course Organic Chemistry | Practical Course Organic Chemistry [OCP]

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	**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 assessment is done in the form of protocols of the laboratory experiments carried out (approx. 10 laboratory experiments per experiment 2-3 pages protocol) and the proof of the preparation by means of melting point determination. Content of the protocol is the correct experimental set-up, the experimental procedure, as well as a discussion of the experiment with procedure, error (sources), proof of the preparation by measured melting point (cf. with literature value). In this way, the students should prove that they are able to understand the theoretical basics of the experiment, to document their execution of the experiment and to prove the successful synthesis of a preparation. The submitted protocols are graded according to completeness, correctness and comprehensibility/clearness, whereby a one-time correction of the protocols is possible.
The protocol is considered passed if the criteria are fulfilled by more than 50%. The module is considered passed if all protocols or preparations are passed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of organic chemistry, inorganic chemistry

Content:
Reflux boiling, crystallisation, distillation, sluicing, shaking out with immiscible organic solvents, thin layer chromatography, column chromatography

Intended Learning Outcomes:
The students have acquired practical skills for carrying out organic chemical reactions. On the basis of simple reactions, the typical handles of organic chemical work have been learned. After

completing the practical course, the students can correctly prepare and set up an experiment, carry it out, record it, analyse the result obtained and recognise possible causes of incorrect values.

Teaching and Learning Methods:
Through the students' own experiments under supervision, they practise handling chemicals and equipment, thereby acquiring manual skills and experimental dexterity. Approx. 10 experiments are carried out.

Media:
Practical laboratory

Reading List:
H.G. Becker, Organikum, 21. Aufl., Wiley VCH

Responsible for Module:
Prof. Nicolas Plumeré

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

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

Module Description

CS0216: Practical Course Microbiology | Praktikum Mikrobiologie

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	Language: German	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 performance is effected by written protocols of the executed laboratory experiments (About 7 experiments and
for each experiment about 4 pages of protocol). With these protocols the students prove that they are able to understand the theoretical background of the experiments, to report their experimental procedure and to evaluate their results. Furthermore, they should show that they can discuss deviations of the expected results and possible reasons. Assessment of the course as passed/failed. The course is only passed if the protocol listed above meets the criteria of completeness, correctness and comprehensibility/clarity each to more than 50%, whereby feedback is given on a first draft.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful completion of the module Cell and Microbiology (CS0256) or equivalent.

Content:
Microscopy, methods of colony isolation, colony count, differentiation of bacteria, isolation of microorganisms, identification methods for microorganisms, growth behaviour of microorganisms

Intended Learning Outcomes:
After module participation the students are familiar with the execution of experiments in microbiological labs and able to use the mediated microbiological working techniques at least in main features. They handle aseptic techniques and can identify microorganisms. In addition, they possess a deeper understanding of the theories which underlie the experiments, including the ecological significance of microbial metabolism. Furthermore, the students can report laboratory

experiments in a correct way and evaluate and analyse them by means of the theoretical backgrounds under guidance.

Teaching and Learning Methods:
Laboratory experiments in small groups (approx. 14 experiments) under guidance with previous introduction of the theory related to the particular experiments (lecture) as well as analysis of the results by experiment reports. Aspects related to safety issues in the laboratory are also covered in the lectures.

Media:
Practical course script

Reading List:
Practical course script

Responsible for Module:
Erich Glawischnig

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

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

Module Description

CS0217: Mechanical Process Engineering | Mechanische Verfahrenstechnik [MVT]

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor	**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 examination performance is provided in the form of a written examination. The students prove that they understand the structure and function of apparatuses and can carry out the basics of design, material selection and strength calculation. In the interaction of machines and apparatus, plant concepts are to be designed and/or specific aspects, such as the safety of operation, are to be discussed on the basis of P&Is.
Examination: written, duration: 90 minutes; auxiliary means: calculator

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Technical Mechanics (CS0036), Materials Science (CS0040), Fluid Mechanics (WZ1954)

Content:
The module teaches the basics necessary for the description of particle systems:
Particle size and shape, distribution functions, particle motion and interactions in heaps.
Furthermore, the basic operations applied to particles are presented: Crushing, mixing, separating, agglomerating, fixed and fluid beds, filtration.
For example, reference is made to applications in material and energy systems with regard to wood chipping, conveying, fermenter stirring and biomass combustion.

Intended Learning Outcomes:
After participating in the module, the students are able to apply the mathematical fundamentals of particle technology and to interpret the basic operations of particle process technology.

Teaching and Learning Methods:
The module consists of lecture and exercise.
The content of the module is conveyed during the lecture by speech and presentations. The students are encouraged to engage actively with the topics by integrating various self-search tasks and comprehension questions.
In the exercises, which take place in alternation with the lecture, serve for a stronger comprehension of the teaching contents. Hence, the students work on various calculation exercises and conduct different lab experiments in small groups.

Media:
Presentations, exercises

Reading List:
Bohnet, M., Hg.; 2014. Mechanische Verfahrenstechnik. Weinheim: Wiley-VCH-Verl. ISBN 9783527663569
Müller, W., 2014. Mechanische Verfahrenstechnik und ihre Gesetzmäßigkeiten. 2. Aufl. München: De Gruyter. Studium. ISBN 3110343568.
Rhodes, M.J., 2008. Introduction to particle technology. 2nd ed. Chichester, England: Wiley. ISBN 047072711X.
Schubert, H., 1990. Mechanische Verfahrenstechnik. Mit 36 Tabellen. 3., erw. und durchges. Aufl. Leipzig: Dt. Verl. für Grundstoffindustrie. Verfahrenstechnik. ISBN 9783342003816.
Schwister, K., Hg., 2010. Taschenbuch der Verfahrenstechnik. Mit 49 Tabellen. 4., aktualisierte Aufl. München: Fachbuchverl. Leipzig im Carl-Hanser-Verl. ISBN 3446424350.
Stiess, M., 1997. Mechanische Verfahrenstechnik 2. Berlin, Heidelberg: Springer Berlin Heidelberg. Springer-Lehrbuch. ISBN 978-3-662-08599-8.
Stiess, M., 2009. Mechanische Verfahrenstechnik. Partikeltechnologie. 3., vollständig neu bearbeitete Aufl. Berlin, Heidelberg: Springer Berlin Heidelberg. Springer-Lehrbuch. ISBN 978-3-540-32552-9.
Zogg, M., 1993. Einführung in die mechanische Verfahrenstechnik. Mit 29 Tabellen und 32 Berechnungsbeispielen. 3., überarb. Aufl. Stuttgart: Teubner. ISBN 9783519163190.

Responsible for Module:
Prof. Matthias Gaderer

Courses (Type of course, Weekly hours per semester), Instructor:
Mechanical process engineering (Exercise) (Übung, 2 SWS)
Gaderer M [L], Fang W, Herdzik S

Mechanical process engineering (Lecture) (Vorlesung, 2 SWS)
Gaderer M [L], Fang W, Herdzik S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0218: Practical Course Biochemistry | Praktikum Biochemie [Pra BC]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Die Lernergebnisse werden in einer 30 minütigen mündlichen Prüfung überprüft, in der die Studierenden zeigen, dass sie die theoretischen Hintergründe der Versuche verstanden haben. Darüber hinaus sollen die wichtigsten Ergebnisse der laborpraktischen Versuche berichtet und diskutiert werden und es sollen Fragen zu den durchgeführten Experimenten beantwortet werden können.
Durch die korrekte Durchführung aller Laborexperimente mit korrekter Protokollierung (pro Experiment etwa 5 Seiten Protokoll) weisen die Studierenden zudem nach, dass sie die vermittelten experimentellen Arbeitstechniken anwenden und Laborexperimente ordnungsgemäß dokumentieren können (unbenotete Studienleistung).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Praktikum Mikrobiologie

Content:
Im Praktikum werden allgemein notwendige Grundlagen für das Arbeiten in biochemischen Laboren, sowie spezielle Methoden zur Trennung und Charakterisierung von Molekülen vermittelt. Darüber hinaus werden grundlegende biochemische Methoden vermittelt, insbesondere die Isolierung von Nukleinsäuren und Proteinen und ihre Analyse mittels Spektroskopie und Gelelektrophorese, sowie die Analyse enzymkatalysierter Reaktionen.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden mit dem Ausführen von Experimenten in biochemischen Laboren vertraut und in der Lage, die vermittelten experimentellen Methoden mindestens in den Grundzügen anzuwenden. Sie besitzen zudem ein tieferes

Verständnis der Theorien, die den Experimenten zugrunde liegen. Darüber hinaus können die Studierenden Laborexperimente korrekt protokollieren und anhand der theoretischen Hintergründe unter Anleitung auswerten und analysieren. Sie können ihre Ergebnisse kritisch hinterfragen und auf Plausibilität überprüfen. Die Studierenden verfügen somit über grundlegende praktische Fähigkeiten um in biologisch-chemischen Laboratotien an neuen, biobasierten Synthesen für eine nachhaltige Chemie zu arbeiten.

Teaching and Learning Methods:
Laborexperimente in Kleingruppen unter Anleitung mit vorheriger Einführung in die Theorie zu den einzelnen Experimenten, sowie Auswertung der Ergebnisse in Form von Versuchsprotokollen. In der Übung wird das Dokumentieren und Auswerten der Versuche anhand vorgegebener Daten und Fragestellungen erlernt. Die in der Übung erworbenen Fähigkeiten werden dann bei der Auswertung und Dokumentation der eigenen Experimente angewendet.

Media:
Praktikumsskript, ppt-Präsentationen, Tafelanschrift, Labor, Laborgeräte

Reading List:
Praktikumsskript

Responsible for Module:
Prof. Volker Sieber

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

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

Module Description

CS0219: Protein-based Materials for Technology | Protein-based Materials for Technology

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** 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 performance test will be in the form of a written examination. The students should demonstrate an understanding of the lecture content and its applications to problems related to proteins-based materials in the exam. No auxiliary means are allowed in the exam. 120 min examination time.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
This course will intend to consolidate concepts in Physics, Mechanics, Physical Chemistry, Biology, Engineering, and Chemistry having the focus on articles describing protein-based materials and their used in technological platforms. As such, knowledge in Physics, Chemistry, Mechanics, and Biology is required.

Content:
The module aims to provide in-depth knowledge to the students in physical chemistry, spectroscopy, thermodynamic, protein structure, and optoelectronics applied to protein-based materials. The module will study scientific articles that describe protein-based materials. The first focus will be on extracting information about the structure-functionally relationship of proteins and their interaction with other molecules and macromolecules and the different techniques used for that purpose. The second focus will be on studying how protein-based materials can have applications outside the typical biology range.
The course will study at least one scientific article per session to cover protein-based materials with applications in optoelectronics, medicine, and chemistry.
Each topic will be addressed, refreshing the most important physicochemical principles and more useful techniques followed by their relevance in these materials' structural and functional aspects and their application.

Intended Learning Outcomes:
At the end of the module, the students will be able i) to critically evaluate the information in scientific articles relating to novel protein-based materials for technology; ii) to analyze protein-based materials using a physicochemical perspective; iii) to describe the different ways protein interact with other molecules or macromolecules to form functional materials; iv) to describe the main role and characteristics of protein-based materials in technological platforms. They will be able to examine the structure of proteins and other molecules and macromolecules and the forces that define their functionality. They will be able to apply these concepts in bio-based and bio-inspired technologies.

Teaching and Learning Methods:
This course attendance includes lectures and seminars. For this purpose, powerpoint presentations, practical training materials, and open discussion seminars will be used.

Media:
The following forms of media apply: script, powerpoint, films, and blackboard

Reading List:
1. Physical Chemistry for the Biological Sciences, 2nd Edition Gordon G. Hammes, Sharon Hammes-Schiffer, Wiley, 2015, ISBN: 978-1-118-85900-1
2. Physical Chemistry for the Life Sciences, 2ndEdition Peter Atkins and Julio De Paula Oxford University Press ISBN: 978-0-19-956428-6
3. Introduction to Biophotonics Paras N. Prasad Wiley 2003, ISBN: 0-471-28770-9.
4. Introduction to Biomechanics Duane Knudson Springer 2007 ISBN: 978-0-387-49311-4

Responsible for Module:
Costa Riquelme, Rubén Dario; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Protein-based materials for technology (Vorlesung, 2 SWS)
Costa Riquelme R [L], Costa Riquelme R, Atoini Y, Banda Vazquez J

Protein-based materials for technology (Exercise) (Übung, 2 SWS)
Costa Riquelme R [L], Costa Riquelme R, Atoini Y, Banda Vazquez J
For further information in this module, please click campus.tum.de or here.

Module Description

CS0220: General Chemistry | Allgemeine Chemie [Chem]

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**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 performance test will be in the form of a written examination rendered. The students should demonstrate in the exam the understanding of the structure of chemical compounds and their typical reactions and chemical conversions. It will also be tested the ability to formulate reaction equations, calculate reaction kinetic and thermodynamic parameters, as well as to transfer the acquired knowledge about the structure and reaction behavior of chemical substance groups to new chemical questions. No auxiliary means are allowed in the exam. 90 min examination time

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of chemistry, mathematics and physics, which correspond to the basic course knowledge of the gymnasiale upper school

Content:
General principles of inorganic and physical chemistry: Atomic and molecular construction, structure of compounds, acid / base equilibria, redox reactions, thermodynamics, reaction kinetics and catalysis, fundaments on electrochemistry, selected reactions of inorganic chemistry

Intended Learning Outcomes:
The students will know and understand the basic principles of chemical reactions and will be able to formulate correct reaction equations and simple reaction kinetic and thermodynamic calculations. Moreover, they will be able to apply the knowledge acquired with model reactions about chemical transformations of chemical substances and substance groups to answer new chemical questions. The successful participation in the module will enable the students to participate in the module of basic organic chemistry

Teaching and Learning Methods:
Lectures and corresponding exercises with self-analysis and workup of specific case studies. In relation to the teaching content exercise sheets are disbursed on which the students work in self-study before the tutorials. The solution and discussion takes place in the tutorials. At the postprocessing of the lecture exspecially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the structure and reaction behavior of chemical substance groups and practise the formulation of reaction equations.

Media:
Blackboard, presentation (using script), exercises.

Reading List:
1) Theodore L., H. Eugene LeMay, Bruce E. Bursten, Chemie Studieren Kompakt, 10. aktualisierte Auflage, Pearson Verlag, München
2) Charles E. Mortimer, Ulrich Müller, Chemie, 10., überarbeite Auflage, Thieme Verlag, Stuttgart

Responsible for Module:
Prof. Herbert Riepl

Courses (Type of course, Weekly hours per semester), Instructor:
Allgemeine und anorganische Chemie / Angleichung Chemie (Vorlesung) (Vorlesung, 2 SWS)
Riepl H [L], Riepl H

Allgemeine und anorganische Chemie (Übung) (Übung, 2 SWS)
Riepl H [L], Riepl H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0220: General and Inorganic Chemistry | Allgemeine und Anorganische Chemie [Chem]

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**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 performance test will be in the form of a written examination rendered. The students should demonstrate in the exam the understanding of the structure of chemical compounds and their typical reactions and chemical conversions. It will also be tested the ability to formulate reaction equations, calculate reaction kinetic and thermodynamic parameters, as well as to transfer the acquired knowledge about the structure and reaction behavior of chemical substance groups to new chemical questions. No auxiliary means are allowed in the exam. 90 min examination time

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of chemistry, mathematics and physics, which correspond to the basic course knowledge of the gymnasiale upper school

Content:
General principles of inorganic and physical chemistry: Atomic and molecular construction, structure of compounds, acid / base equilibria, redox reactions, thermodynamics, reaction kinetics and catalysis, fundaments on electrochemistry, selected reactions of inorganic chemistry

Intended Learning Outcomes:
The students will know and understand the basic principles of chemical reactions and will be able to formulate correct reaction equations and simple reaction kinetic and thermodynamic calculations. Moreover, they will be able to apply the knowledge acquired with model reactions about chemical transformations of chemical substances and substance groups to answer new chemical questions. The successful participation in the module will enable the students to participate in the module of basic organic chemistry

Teaching and Learning Methods:
Lectures and corresponding exercises with self-analysis and workup of specific case studies. In relation to the teaching content exercise sheets are disbursed on which the students work in self-study before the tutorials. The solution and discussion takes place in the tutorials. At the postprocessing of the lecture exspecially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the structure and reaction behavior of chemical substance groups and practise the formulation of reaction equations.

Media:
Blackboard, presentation (using script), exercises.

Reading List:
1) Theodore L., H. Eugene LeMay, Bruce E. Bursten, Chemie Studieren Kompakt, 10. aktualisierte Auflage, Pearson Verlag, München
2) Charles E. Mortimer, Ulrich Müller, Chemie, 10., überarbeite Auflage, Thieme Verlag, Stuttgart

Responsible for Module:
Prof. Herbert Riepl

Courses (Type of course, Weekly hours per semester), Instructor:
Allgemeine und anorganische Chemie / Angleichung Chemie (Vorlesung) (Vorlesung, 2 SWS)
Riepl H [L], Riepl H

Allgemeine und anorganische Chemie (Übung) (Übung, 2 SWS)
Riepl H [L], Riepl H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0221:

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor	**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 examination consists of a 90 minutes written test (either written or e-test), including knowledge questions as well as a section where the students will have to apply the learned coding skills to find a solution to a presented question of interest. The knowledge questions aim to check the students' understanding of the fundamental concepts of classification, methods, and structures in data science and discuss them.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The module covers the following contents:
Basic algorithms and data structures:
- Database management systems
- Algorithms and their classification
- Data structures for sequences, linked lists, stacks, queues
- Recursion
- Recognition of patterns
- Hashing, chaining, probing
- Search methods
- Sorting methods
Specific fields of application in material science, for example:
- Molecular docking (grahite, tubes, metal)
- Adsorption and desorption
- Molecular dynamics

- Surface tension
- Orientation at surfaces

Intended Learning Outcomes:
After successful participation in this module, students will be able to understand the fundamental and underlying concepts and logic of data science, in particular database management systems, programming, algorithms and data classification and organization. They can utilize this knowledge for developing own code and fundamental algorithms. These are applied to analyze scientific data for specific fields of interest in material science.

Teaching and Learning Methods:
The module consists of both, lectures and exercises. The lectures teaches the students the basics of data structures and fundamental algorithms of programming, which are necessary for developing own code to analyze scientific data. The students then will apply this in guided exercises in example problems and write own code to analyze specific data from research in material science.

Media:
PowerPoint presentation, whiteboard, discussion forums and interactive tools in Moodle, exercise sheets, computer based exercises.

Reading List:
June Gunn Lee, 2016, Computational Material Science: An Introduction, CRC Press
Richard LeSar, 2013, Introduction to Computational Material Science: Fundamentals to Applications, Cambridge University Press
Heinz-Peter Gumm, Manfred Sommer, 2012, Einführung in die Informatik, Degruyter Oldenbourg
Marco Emrich, 2013, Datenbanken & SQL für Einsteiger, Create space independent publishing platform
Learning Scientific Programming with Python, Christian Hill
Data Structures & Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser

Responsible for Module:
Prof. Dr. Rubén D. Costa

Courses (Type of course, Weekly hours per semester), Instructor:
Informatik für Materialwissenschaften (Übung) (Übung, 2 SWS)
Costa Riquelme R [L], Costa Riquelme R

Informatik für Materialwissenschaften (Vorlesung) (Vorlesung, 2 SWS)
Costa Riquelme R [L], Costa Riquelme R
For further information in this module, please click campus.tum.de or here.

Module Description

CS0222: Protein Chemistry | Protein Chemistry [ProtCh]

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**Language:** German/English	**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 T pci ist of-l□cord know how proteins can be characterised. In addition they can describe the impact of modifications on the protein structure or activity and apply their theoretical knowledge by means of questions.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations and blackboard sketches. Corresponding to the teaching content exercise sheets are prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentations, PowerPoint, script, exercise sheets

Reading List:
Bioanalytik, F. Lottspeich, H. Zorbas, Spektrum Akademischer Verlag
Voet, D. , Voet, J.G., Biochemistry 4th Edition, Wiley-VCH, 2011; Nelson, D.L, Cox, M.M., Lehninger Principles of Biochemistry 5th Edition, WH Freeman, 2008; Berg, J.M, Tymoczko, J.L., Stryer, L., Biochemistry 6th Edition, 2006

Responsible for Module:
Prof. Volker Sieber Ammar Al-Shameri

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

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

Module Description

CS0223: Accredited Module 7,5 ECTS | Anerkanntes Modul 7,5 ECTS

Version of module description: Gültig ab winterterm 2020/21

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 7.5	**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

CS0225: Flow Biocatalysis | Flow Biocatalysis [FCB]

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 75	**Contact Hours:** 45

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

Description of Examination Method:
The learning results are proved in form of a presentation and a discussion (30 min per participant, 50 % of grade).A written report to the experiments has to be also submitted). Based on current developments in flow chemistry and enzymatic biotransformation the students must prove their knowledge to the corresponding state of the art and technical terms, their skill to design and conduct enzymatic cascades in flow, and their ability to evaluate obtained results and identify bottlenecks. Students must prove that they have understand the basics of flow biocatalysis and its applications in academia and industry.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Students must have been successfully completed the course “enzymatic biotranformation, CS 0009” in order to be enrolled to this course.

Content:
Principles of flow chemistry (flow reactor design, fluid dynamics, residential time)
Enzyme immobilization techniques (absorption, covalent, ligand interaction)
Introduction to PAT (process analytical technology) in flow biocatalysis
Examples of enzymatic cascades in flow (recent scientific reports and articles)
Principles of flow biocatalysis with whole cells (biofilms)
Flow biocatalysis in industry.

Intended Learning Outcomes:
After visiting the module, students know fundamentals of flow biocatalysis and first-hand experience in enzymatic purification and immobilization. They have deepend their previous knowledge of enzymatic biotransformation by performing a multi-enzymatic cascade in flow to

produce fine chemicals. They understand the interaction between the different parameters of multi-enzymatic cascades; they can determine the bottlenecks of such cascades and find solutions to overcome them. Furthermore, the students gained a border perspective about the different techniques for enzyme purification and immobilization, product extraction and quantification, and calculations of reaction efficiency. Finally, the students learned how to transfer their knowledge towards industrial processes and address the environmental and economic challenges related to them.

Teaching and Learning Methods:
The content of the module is taught theoretically in the seminar (1 SWS). The experimental part of the module will be taught in form of a practical course (2 SWS). In the lecture the content will be conveyed by speech of the lecturer using PowerPoint presentations and Whiteboard sketches. This enables a way of delivering the teaching content to the students in details and answering the arose questions straight-ahead. PowerPoint slides and sketches create a visual assistance to understand the content. Additionally, the students will be provided with the recent published literature on flow biocatalysis to bring their knowledge to edge of the current science. A Part of the literature content will be introduced into the Power point slides to assist students in understanding scientific articles. In the practical course, students will learn how to design and construct a flow reactor for enzymatic cascades. They will learn how to purify enzymes and immobilize those using different techniques. Finally, students will integrate the immobilized enzymes into the flow reactor to perform a multi-enzymatic cascade and will evaluate the final product using analytical methods.

Media:
Presentations, PowerPoint, script

Reading List:
Recent published scientific articles and reviews. It will be provided prior to the course.

Responsible for Module:
Ammar Al-Shameri (a.al-shameri@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

CS0226: Corporate Strategy | Corporate Strategy

Version of module description: Gültig ab winterterm 2022/23

Module Level: Bachelor/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:
Group Project and Group Presentations: 60%; Online Exam (60 min.): 40%

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge of business administration

Content:
Students are introduced into the topic of corporate strategy based on a thorough understanding of what strategy means in the context of corporate management. Further, students learn about key management analysis tools and whose application to real life scenarios by the means of case studies. Subsequently, corporate strategy is looked at from a regional, national and international perspective including the notion of innovation and the formation of competitive advantage.

Intended Learning Outcomes:
The students obtain knowledge in
• gaining a broad understanding about core themes of corporate strategy, related processes and theoretical underpinnings,
• understanding strategic analysis tools in the context of case studies and further examples
• developing a critical understanding of strategy in the context of corporate management with the objective to improve strategic decision making, and
• obtaining the ability to develop managerial reports based on the above.

The student enhance their skills in
• evaluating presented information in a critical manner based on the information presented in the course,

• applying strategic analysis tools and interpret the results of such analysis,
• presenting the results of his/her work in a concise way to a larger audience, and
• connecting local/regional/national corporate strategy topics to an international context.

The student obtain further general qualifications in
• having insights into relevant topics and issues in the context of corporate strategy,
• applying relevant theoretical frame works to case studies and demonstrate an in-depth understanding of the results,
• planning and executing relevant project work in a timely fashion in the context of a group project,
• presenting and contextualizing relevant information, theories and issues of the corporate strategy domain (oral and written),
• discussing relevant information and topics with peers as part of the course, and
• connecting the concept of innovation to corporate strategy and business success

Teaching and Learning Methods:
The basic concepts are presented with slide-based lectures. The models and methods are presented and illustrated by means of exercise examples, including practical applications in corporate strategy management. These contents form the basis for a critical consideration from a theoretical-conceptual and practical-application-oriented point of view. Current research papers, case studies and textbooks are used as the basis for this.

Media:
Core text book, case studies, academic journal articles, lecture slides, relevant online content

Reading List:
Exploring Strategy by Johnson, Whittington and Scholes

Responsible for Module:
Prof. Alexander Hübner

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

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

Module Description

CS0227: LCA Case Studies | LCA Case Studies [LCA CS]

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
Written group assignment and oral group presentation: Students are training their skills in Life Cycle Assessment by carrying out and report a small LCA study including data collection. Students are free to use the openLCA software for modelling. Performing the calculations with spread-sheets is also fully accepted.

In groups of at least two persons, students identify and select a topic for their LCA case study. Each group has to perform all four phases of an LCA. This consists of
- Writing a goal and scope definition,
- Collecting data for carrying out the inventory analysis,
- Selecting suitable life cycle impact categories and performing a life cycle impact assessment,
- Interpreting the results, discussing the own study including its limitations by comparing it with other LCA studies/reports in the same/similar topic.
- Presenting the results in form of a presentation and a written report

The examination consists of three parts. The weighting is as follows:
(1) Goal and scope definition (20%)
(2) Final presentation (30%)
(3) Final report (50%)

In the Goal and Scope Definition (~5 pages), the topic and purpose of the LCA case study is established and decisions are made about the product system being studies. In drafting the goal and scope definition, students show that they are able to identify and select an object for analysis, to structure a problem and plan the outset and further steps of their study.

In the final group presentation (25'), students present their results and have to show that they are able to summarize their findings in a scientific presentation, discuss and defend them (15' for presentation, 10' for discussion).

In the final report (15-20 pages), the students show that they are able to perform a simple LCA case study. Moreover, they proof their study design in a transparent and logical way. By presenting the results of the LCA case study as well as discussing the findings and limitations, students proof their ability to find relevant literature, carry out a small LCA study and document the results of the process in a scientific paper.

Repeat Examination:

(Recommended) Prerequisites:
The contents of the module Advanced Sustainability and Life Cycle Assessment is required. It can be obtained in parallel to this seminar.

Content:
The module contains units covering the following topics:
• Systems and life cycle thinking
• Life Cycle Assessment
• Goal and Scope Definition to plan the outline of the LCA study
• Life Cycle Inventory for data collection and reconciliation
• Life Cycle Impact Assessment to assess the potential environmental impacts
• Handling of data uncertainty
• Literature research and current trends and developments
• Software systems and databases for life cycle assessment
• Case studies

Intended Learning Outcomes:
The students use the concepts and tools of life cycle assessment. The goal is to be able to analyse industrial metabolisms as well as products and services regarding their environmental impacts. Thus, students gain a deeper understanding of the LCA methodology and procedure by applying the theoretical knowledge to a practical example.
At the end of the module students are able to carry out an own LCA. This involves carrying out the four phases of an LCA study
• the goal and scope definition phase: to identify and select a suitable product or service system to carry out an LCA case study, explain the key aspects of the goal and scope definition and their relevance for the subsequent LCA phases, to define a functional unit and reference flow for the LCA case
• the inventory analysis phase: to collect the input/output data with regard to the system being studied.
• the impact assessment phase: to address the environmental aspects and potential environmental impacts throughout the life cycle of a product or a service system.
• the interpretation phase: the results of the life cycle inventory and life cycle impact assessment are summarized and discussed as a basis for conclusions, recommendations and decision-making in accordance with the goal and scope definition.

Applying LCA methodology can support further development and improvement of systems, products, and services. This can support decision-making processes, marketing and product/ service improvement in the context of various stakeholders.

Teaching and Learning Methods:
Seminar: In parallel to the lecture "Advanced Sustainability and Life Cycle Assessment", this seminar format provides the opportunity to apply the theoretical knowledge of LCA by applying it to a small LCA case study and gaining a deeper understanding of the LCA methodology. After an introduction to the topic, the students identify a product/service system to analyse, carry out a full LCA (incl. data collection, literature research). They receive intermediate feedback to a Goal and Scope Definition of their study. In a next step they carry out a full LCA. In this process they are supervised, receive materials, thematic input, advice in scientific work and continuous feedback in the seminar sessions. The seminar closes with a final presentation.

Teaching / learning methods:
• Kick-off meeting
• Media-assisted presentations
• Video-based tutorials for methodology (e.g. LCA software)
• Individual work and feedback consultations
• Group work / case studies with presentation
• Interim presentations / workshops
• Final group presentations
• Group assignments

Media:
Digital projector, board, flipchart, online contents, videos, case studies, LCA software, presentations

Reading List:
Recommended reading:
• Curran, M.A. (2015): Life Cycle Assessment Student Handbook, Scrivener Publishing.
• Fröhling, M.; Hiete, M. (2020): Sustainability and Life Cycle Assessment in Industrial Biotechnology. Springer, Cham.
• Guinée, J.B. (2002): Handbook on life cycle assessment: operational guide to the ISO standards. Kluwer, Dordrecht.
• Hauschild, M.Z. & Huijbregts, M.A.J. (2015): Life Cycle Impact Assessment (LCA Compendium - The Complete World of Life Cycle Assessment), Springer, Cham.
• Hauschild, M.; Rosenbaum, R.K.; Olsen, S.I. (2018): Life Cycle Assessment: Theory and Practice. Springer, Cham.
• Jolliet, O., Saade-Sbeih, M. (2015): Environmental Life Cycle Assessment. CRC Press.
• Klöpffer, W. & Grahl, B. (2014): Life Cycle Assessment (LCA), Wiley-VCH.

Responsible for Module:
Fröhling, Magnus; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
LCA Case Studies (Seminar, 3 SWS)
Fröhling M [L], Schirmeister J, Corella Puertas M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0228: Technology and Management of Renewable Energies in a Global Context | Technology and Management of Renewable Energies in a Global Context [REAE]

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
The exam will be in form of an oral presentation of the students (20+10 minutes; 75% of the grade) and a short report of the students' project work (max. 5 pages, not counting front page and cited literature; 25% of the grade).

In this students' project, the students demonstrate understanding of specific questions related to a defined topic concerning the technology and management of renewable energies in a global context. Students have to show in their presentation that they can analyse, solve and answer defined problems and questions related to this topic. Participants of the course show that they have done appropriate research work and are able to present their results. By answering follow-up questions related to their presentation they show that they have learned to put their research outcome into the relevant technical or country context. The presentation slides and the short report will be handed over to the lecturers and will be included in the grading.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic know-how related to specific techniques of renewable energies (e.g. solar energy, wind energy, hydropower, biomass conversion technology, geothermal energy) as well as management of energy systems either on a company or on state level.

Content:
A) Technical aspects of different forms of renewable energies (e.g. current state of technology, technical options for the future, technical bottlenecks, scale-up possibilities)
- Wind power

- Hydropower
- Photovoltaics, solarpower
- Geothermal energy
- Biomass use for energy purposes
- Biofuels, electric vehicles, E-fuels
- Hydrogen
- Other forms of renewable energies

B) Economic aspects related to defined renewable energies (e.g. cost of use/production, cost structure and development in the past, learning curves, innovation and diffusion of renewable energies)
C) Influencing factors for adoption and use of renewable energies (e.g. natural/local conditions, availability of renewable resources, technical infrastructure, user structure of energy, cost and economic factors, financing, political and regulatory issues, social acceptance, behaviour of stakeholders and people)
D) Situation and development in a specific (country) context (e.g. governance, policy goals and activities, competing factors and interests (e.g. by fossil energy use or related companies/ stakeholders), legal and regulatory stability)

Intended Learning Outcomes:
At the end of the module, students will be able to analyse and elaborate solutions for existing problems related to the technology and management of renewable energies and apply such solutions to the specific context of selected countries worldwide. They consider both the technical side as well as the economic and management dimension in order to develop integrated solutions for a specific question related to renewable energies. Additionally they take the specific context and situation (e.g. technical infrastructure and know-how, maintenance, electrical or other grids, political and regulatory rules, economic framework, company and user structure) in one or several countries or regions into account when analysing and elaborating solutions for the question on-hand. They are able to apply their knowledge to create an oral presentation and a written summary of their findings. Presented results are discussed with the audience so that students are able to defend their solution and put it in an appropriate context.

Teaching and Learning Methods:
The module is a seminar, where course participants form (preferably international) teams that investigate a given topic by autonomously doing research work and discussing results within the team. During regular meetings with the lecturers questions can be discussed, next steps are defined and (interim) results are presented. Lecturers will provide basic and background material for the students as well as actual information for the given topics that are elaborated by the student teams.

Learning activities: Literature/document research, student group project

Media:
Presentation slides, online discussion forum (all lecture materials are available via Moodle)

Reading List:
Specific literature and documents will be provided to the topics that are worked on in the student projects

Responsible for Module:
Menrad, Klaus; 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

CS0230: Applied Electrochemistry | Angewandte Elektrochemie [Appl. EC]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 achievement of the learning objective is checked by a written examination (examination time: 60min). Up to 10% of the total number of points can be added to the grade of this written examination as bonus points. The results of the online tests held during the semester determine the amount of bonus points. At least 65% of the points in the online test must be achieved in order to receive bonus points. It is not possible to raise the grade from 4.3 or worse to 4.0. This should encourage the students to continuously participate in the lectures and exercises that are very important for them. By means of questions on electrochemical aspects, the students prove that they know the relevant technical terms, designations and contents, have understood the basic interrelationships and can apply their knowledge of the processes taking place within the framework of electrocatalysis, local electrochemistry as well as spectroelectrochemistry. Concrete computational tasks are set for this purpose.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Allgemeine Chemie and Physikalische Chemie, Mathematik, Physik, Einführung in die Elektrochemie or other introductory lectures to electrochemistry.

Content:
- Electrochemistry of surface-bound species: The ideal case (Langmuir isotherm) and deviations (Frumkin isotherm). Heterogeneous electron transfer (Laviron formalism) to surface-bound species.
- Local electrochemistry: electrochemistry at microelectrodes, scanning electrochemical microscopy.

- Electrochemistry at the nanoscale: mass transfer & kinetics at heterogeneous electrodes. Applications of nanoparticle-modified electrodes. Single nanoparticle electrochemistry.
- Electrocatalysis: Molecular electrochemistry - theory and practice. Heterogeneous electrocatalysis - theory and practice. Methods in electrocatalysis research (DEMS, ICP-MS, FTIR, Raman, etc). Applications (electrochemistry and electrocatalysis of CO2, O2 and H2).
- Spectro-electrochemistry: coupling of EPR, UV-Vis, IR, Raman spectroscopy with electrochemistry. Electropolymerisation/conducting polymers. Correlation between optical properties, energy levels and redox potentials.

Intended Learning Outcomes:
The students learn the advanced knowledge of fundamental concepts of electrocatalysis, local electrochemistry and spectroelectrochemistry with reference to specific application examples. They are able to deal with the general principles of electrocatalysis and local electrochemistry and apply them to simplified problems of real electrochemical systems. A special focus is put on the understanding of the general and temporal interplay of electron transfer, chemical reactions and mass transport, in different electrocatalytic systems. Special focus will be on the theory of surface bound species, as well as molecular, heterogeneous and nanoparticle electrocatalysts. Furthermore, students will be familiar with electrochemical characterisation methods and will be able to apply their theoretical knowledge to these areas. Furthermore, students are familiar with industrially relevant processes, renewable energy conversion, green electrosynthesis and sustainable energy production and storage and can apply their theoretical knowledge to these areas. In addition, they know electrochemical characterisation methods and can apply them to real examples to design and optimise processes in research and industry.

Teaching and Learning Methods:
In this lecture, the course content is delivered through lectures by the lecturer using a fluent PDF script, PowerPoint slides and blackboard images. This allows for a detailed presentation of the course content and students are able to ask and discuss questions as they arise. PDF-script, PowerPoint slides and blackboard images provide visual support to help students understand the complexities of electrochemistry. In addition, students are provided with exercises to consolidate the content learned in the lecture. The solutions to these exercises are later presented and discussed by the students in an exercise lesson.

Media:
Presentations, PowerPoint, script.

Reading List:
Electrochemical Methods: Fundamentals and Applications; Bard/Faulkner, ISBN-13: 978-0471043720

Responsible for Module:
Prof. Nicolas Plumeré Dr. Ben Johnson Dawit Tedros Filmon

Courses (Type of course, Weekly hours per semester), Instructor:
Angewandte Elektrochemie (Übung) (Übung, 1 SWS)
Plumeré N [L], Filmon D

Angewandte Elektrochemie (Vorlesung) (Vorlesung, 2 SWS)
Plumeré N [L], Plumeré N
For further information in this module, please click campus.tum.de or here.

Module Description

CS0231: Reaction Engineering and Fluid Separations | Chemische und Thermische Verfahrenstechnik

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	Language: German/English	Duration: one semester	Frequency: summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 180	**Contact Hours:** 120

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

Description of Examination Method:
The learning outcomes of the students will be tested in a written exam. There will be computational tasks on reaction engineering as well as thermal separation processes and reaction engineering. Students demonstrate that they can diagram and explain kinetics in engineering reactors. They demonstrate that they can answer questions about the fundamentals of catalysis. The design and balancing of process steps and the application of basic concepts and relationships in thermal separation technology will be examined. On the basis of various tasks (including computational tasks), the ability to solve the acquired knowledge to solve basic process engineering problems (design of stirrers, tubular reactors, etc.) within a limited time is tested.
Duration of examination: 120 minutes, auxiliary means: Four A4 pages of any written / printed paper and a non-programmable pocket calculator.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of Thermodynamics (CS0065), General Chemistry (CS0220)

Content:
Reaction kinetics, catalysts, features of homogeneous and heterogeneous catalysis; chemical reaction technology: homogeneous/heterogeneous reactions, reactor forms (e.g. stirrer tanks, tube reactor, packed bed, fluidized bed), indicators for reactor types (e.g. reaction vessels, flow tube), types of reaction control (e.g. fixed, not fixed, continuous, isothermal), flow conditions, and residence time behavior in reactors, heat balance of reactors, strategies for optimizing reaction control. Introduction to fluid separation processes, design methods (calculation and graphical), single-stage and multi-stage operations, Mc-Cabe-Thiele-Construction, HTU-NTU-concept, fixed-

point construction for extraction columns, feasibility limitations of unit operations. Applications in the field of distillation, absorption, extraction, membranes, adsorption.

Intended Learning Outcomes:
After having participated in the module the students are familiar with the most important reaction types and parameters of chemical catalysis and reaction technology and are able to apply suitable reaction controls for predefined chemical reactions, to perform kinetic calculations for common reaction types as well as to calculate parameters such as residence time behavior and heat demand of reactors. Thus, they are capable of also transferring methods learned from examples to new processes. After completion of the module, the students are able to design and assess the fluid separation processes distillation, extraction, absorption and membranes based on state diagrams. In addition, the students understand the basic principles of the said separation processes and the apparatus employed in an industrial context.

Teaching and Learning Methods:
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the module, learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Supporting videos, script presentation sheets, exercise sheets

Reading List:
O. LEVENSPIEL: Chemical Reaction Engineering. 3. Auflage, John Wiley & Sons, New York (1998)
G. EMIG, E. KLEMM: Chemische Reaktionstechnik. 6. Auflage, Springer Vieweg, Berlin (2017)
SATTLER, K.: Thermische Trennverfahren: Grundlagen, Auslegung, Apparate, 3. Auflage, Wiley-VCH, Weinheim, 2002.

Responsible for Module:
Prof. Jakob Burger

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

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

Module Description

CS0231BOK: Biology of Aging | Biology of Aging

Version of module description: Gültig ab summerterm 2021

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

CS0232: EuroTeQ Remote Energy Lab | EuroTeQ Remote Energy Lab [REL]

EuroteQ Engineering University - Online Courses

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
The students will either write a short report on the experimental session or prepare a short newspaper article. Templates and guidelines for the reports or newspaper article will be provided. The three deliverables are weighted equally.

Repeat Examination:

(Recommended) Prerequisites:
Background in technical engineering and/or natural sciences

Content:
In the course hosted by different European universities three sustainable technologies are introduced and studied. For every technology, we offer one lecture and one experimental session. The course is completely online.

Vanadium Redox Flow Batteries – Technical University of Munich – Insights into the functionality, electrochemistry and applications of redox flow batteries

Dynamics of Nuclear Reactors – Czech Technical University – Study on the topics of criticality and radioactive reaction kinetics on a nuclear test reactor

Flue Gas Emissions on a Household Boiler - Tallinn University of Technology – Introduction of small-scale solutions of biomass combustion for heat generation in households

Intended Learning Outcomes:
Students are supposed to:
- Assess the presented technologies from a national and international perspective.
- Analyse and calculate key performance indicators for the different experiments.
- Understand the three presented technologies.
- Learn how to work and communicate efficiently in an international, multidisciplinary team.

Teaching and Learning Methods:
The three main lectures are separated across six weeks. Each main lecture consists of one online course in which theoretical foundations are presented, followed by a practical online course the next week, where the lecturer interactively guides the students through the experimental setup. The purpose of the lecture is to introduce the students to the field of the experiment.

Media:
Script, Lecture slides, Video recordings, Online quizzes

Reading List:
Script

Responsible for Module:
Gaderer, Matthias; Prof. Dr.-Ing.

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

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

Module Description

CS0232BOK: Metabolic and Cell Engineering | Metabolic and Cell Engineering

Version of module description: Gültig ab summerterm 2021

Module Level:	Language:	Duration:	Frequency:
Credits:* 2	**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

CS0233: Accredited Module 10 ECTS | Anerkanntes Modul 10 ECTS

Version of module description: Gültig ab summerterm 2023

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 10	**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

CS0233BOK: BOKU: Intercultural Competence | BOKU: Intercultural Competence

Version of module description: Gültig ab summerterm 2021

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:
Continual assessment; 3 subareas:
1) active participation in class activities including small written tasks 30%
2) assessment of individual literature study and reflective tasks in BOKUlearn 20% (mailny between the first 6 sessions)
3) intercultural project (group work): design, execution, presentation; individuall written report 50%
additionally minimum 30% in all three subareas.

Repeat Examination:

(Recommended) Prerequisites:

Content:
Acting successfully in the professional global world requires more than expertise in your scientific field and language skills. Studying abroad helps you to face this challenge and benefit from cultural diversity. But is the experience abroad enough to develop sound Intercultural Competence?
This class does not give you concrete instructions how to negotiate in China or how to collaborate with colleagues from a specific country, but provides you with a general toolkit to react to new cultural situations – wether you plan to go abroad or are currently struggling with becoming acquainted with BOKU/ Austria. Furthermore you will learn to analyse and use your intercultural expertise in your further working life. Cultural diversity is seen as an advantage.

The course addresses three target groups: BOKU students, who have preferably already applied for an exchange semester (Erasmus+ , Ceepus, Joint Study,…), exchange/international students currently at BOKU and BOKU students who have just returned from their stay abroad. (To guarantee the success of the course the lecturers reserve the right to choose a group of mixed nationalities.)

First of all you will become familiar with the major concepts of intercultural competence and global learning. This theoretical input will then be immediately put into practice by using the participants' different backgrounds and different experiences of communication styles, behaviours and other cultural practices. Increasing your awareness of your own culture and cultural sensitivity in general will be the first focus (keywords: culture, identity, self-image, stereotypes) followed by your perception of cultural differences (cultural dimensions, values, behaviour, cultural standards). How can you shift perspectives? How can you prevent intercultural conflicts and communicate effectively? How can you deal with culture shocks and have a successful re-entry after your stay abroad? You will learn to re-evaluate and reflect on your own communication styles and behaviours and find the right way to describe your intercultural skills.

Intended Learning Outcomes:
- be aware of and understand how culture affects their and other people's behaviour
- be able to reflect, analyse and interpret cultural differences (cultural dimensions, values, behaviour, standards) and intercultural phenomena
- be able to re-evaluate and reflect their own communication styles and behaviours
- be able to apply strategies to acting in a successful and responsible manner in an international context
- be able to describe their intercultural competence and to integrate it into their future personal and professional life

Teaching and Learning Methods:

The class is designed to be highly interactive. The first sessions will give a general overview, mainly with a focus on discussions, reflection exercises and in-class simulations. In BOKUlearn you will become familiar with theoretical models of intercultural competence and you will link the theoretical input to the personal attitudes and experiences of the participants. In an intercultural group project, you will then apply your newly developed skills and competences. Finally you will reflect on your experiences in a report.

Media:

Reading List:

Responsible for Module:
Liebl, Agnes; Piringer, Ulrike

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

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

Module Description

CS0233-2: Accredited Module 10 ECTS | Anerkanntes Modul 10 ECTS

Version of module description: Gültig ab summerterm 2023

Module Level:	Language:	Duration:	Frequency:
Credits:* 10	**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

CS0234: Accredited Module 20 ECTS | Anerkanntes Modul 20 ECTS

Version of module description: Gültig ab summerterm 2023

Module Level:	Language:	Duration:	Frequency:
Credits:* 20	**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

CS0234BOK: Organic Chemistry | Organische Chemie

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:**	**Duration:**	**Frequency:**
Credits:* 2	**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

CS0235: Methods and Applications of Synthetic Biology | Methods and Applications of Synthetic Biology

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:
Achievement of the desired learning objectives will be verified in a written final exam (90 minutes). In the exam, the students demonstrate that they understand and can explain the methods and applications covered in the module. Students will also demonstrate that they are able to predict the functions of engineered biological systems and that they can analyse results presented in figures from scientific publications.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamental knowledge in molecular biology

Content:
- DNA synthesis and assembly
- Design of dynamic regulatory circuits
- CRISPR/Cas tools and applications
- Cell-free synthetic biology
- Bottom-up assembly of life-like systems
- Biosensor design
- Optogenetics
- High-throughput screening
- Microfluidics
- Applications of synthetic biology tools in sustainable biomanufacturing, health and environment

Intended Learning Outcomes:
After successful participation in the module, students understand important synthetic biology methods such DNA assembly, cell-free prototyping, CRISPR/Cas tools, optogenetics, automation and high-throughput screens. Students will be able to explain applications of synthetic biology in sustainable biomanufacturing, health and environment. They are also able to discuss risks and benefits of these applications and their impacts on the environment and society.
Furthermore, after completing the module, students can analyze the results of synthetic biology experiments in recent scientific publications, and hypothesize on the outcomes of further experiments.

Teaching and Learning Methods:
The contents of the lectures are conveyed by a talk of the lecturer based on slide-supported presentations. The content of the lecture with be supplemented by self-study of recent scientific publications that are provided to the students. The lecture will be supplemented with quizzes and discussions among students to promote critical reflection and active engagement with the contents.

Media:
Slides, scientific publications (provided), online quizzes

Reading List:
The material in the lecture is sufficient for learning and is provided in the lecture.

Responsible for Module:
Niederholtmeyer, Henrike; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Methods and Applications of Synthetic Biology (Vorlesung, 2 SWS)
Niederholtmeyer H [L], Niederholtmeyer H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0235BOK: General Chemistry; LE | Allgemeine Chemie; VO

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**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

CS0236: Recent Topics in Cell-free and Bottom up Synthetic Biology | Recent Topics in Cell-free and Bottom up Synthetic Biology

Version of module description: Gültig ab winterterm 2023/24

Module Level: 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:
The learning outcomes will be tested by a graded seminar presentation and by active participation in the discussions. In the presentation, the students demonstrate that they are able to understand a scientific publication by extracting its key messages and by presenting its findings and methods in a comprehensible way. In their presentation, they also demonstrate that they can critically evaluate a study.

Repeat Examination:

(Recommended) Prerequisites:
Fundamental knowledge in molecular biology

Content:
The course focuses on recent research in the fields of cell-free and bottom up synthetic biology.
- Cell-free transcription and translation
- Cell-free prototyping to characterize new parts and networks for basic science and applications in sustainable production and health
- Cell-free biomanufacturing
- Cell-free biosensing
- Construction of life-like systems from the bottom up
- Self-replication of biochemical systems
- Synthetic compartments
- Microfluidic methods in cell-free and bottom up synthetic biology

Intended Learning Outcomes:
After successful participation in the module, students are able to explain current methods in cell-free and bottom up synthetic biology. They understand the goals of research in the field and can discuss recent examples from the scientific literature. Furthermore, students will be able to extract key messages from scientific publications and to present them in an engaging manner to their peers. They will be able to logically structure a presentation about a scientific publication, and to judge if its conclusions are supported by the data.

Teaching and Learning Methods:
Students select a recent publication from the field of cell-free and bottom up synthetic biology from a list of topics that is provided. The course begins with a slide-supported presentation by the lecturer to give an overview over the field and to provide instructions to the students. The students prepare a presentation about the selected publication and its methods. Individual meetings will be scheduled to support the students in their preparations. Student presentations take place in the seminar and the presented results will be discussed.

Media:
Slides, scientific publications (provided)

Reading List:
The material provided in the course is sufficient for learning.

Responsible for Module:
Henrike Niederholtmeyer

Courses (Type of course, Weekly hours per semester), Instructor:
Recent topics in cell-free and bottom up synthetic biology (Seminar, 2 SWS)
Niederholtmeyer H [L], Niederholtmeyer H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0236BOK: Chemistry of Biomaterials; LE | Biomaterialchemie; VO

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**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

CS0237: Project Week: Practical Enzyme Engineering | Project Week: Practical Enzyme Engineering [P-EnzEng]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** irregularly
Credits:* 5	**To**		

Teaching and Learning Methods:
Seminar presentation, active participation in experimental planning, lab-work, demonstration of advanced methods by trained scientists, guided evaluation of screening results

Media:
Seminar presentation, screening result files

Reading List:
course script and related scientific papers

Responsible for Module:
Prof. Volker Sieber

Courses (Type of course, Weekly hours per semester), Instructor:
Practical Enzyme Engineering (Praktikum, 4 SWS)
Sieber V [L], Mayer M, Romeis D, Schulz M, Siebert D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0237BOK: Introduction into Synthetic Biology and Technological Impact Assessment; LP | Einführung Synthetische Biologie und Technikfolgenabschätzung; VU

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**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

CS0238: Environmental Behavior and Support for Climate Policies | Environmental Behavior and Support for Climate Policies

Version of module description: Gültig ab winterterm 2021/22

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:
Achievement of desired learning objectives shall be verified in a term paper (max. 10 pages) and an oral presentation in a group. The students will implement their own online survey and present the findings in the context of the relevant literature in a group presentation (each student has to present 10 minutes). The oral presentation shall be assessed according to content and rhetoric aspects. The term paper is written individually and summarizes the relevant literature, empirical method, data, and key findings. Weighting: Term paper 2, Presentation 1.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The successful transition from a fossil fuel economy to a more bio-based and sustainable circular economy requires pro-environmental behavior and public support for long-term climate policies (e.g., climate neutrality by 2050). This course aims to explain the factors of environmental behavior and why citizens support or reject climate change polices. Based on recent empirical findings from psychology and economics, the following factors influencing behavior and policy support are discussed:

- socio-psychological factors and climate change perception (e.g., political orientation, environmental values, risk perception, emotions, etc.),
- the perception of climate policy and design (e.g., perceived costs, perceived fairness, perceived effectiveness, etc.), and
- contextual factors (e.g., social norms, participations, economic and geographical aspects).

The course consists of a lecture that gives an overview of the factors that influence environmental behavior and public support for climate policies. It will also review methodological questions relevant for (online) surveys. In the integrated exercises students will be trained to implement online surveys and experiments. Students will be assigned to groups and conduct their own online survey and investigate factors that influence pro-environmental behavior and the support for climate policies.

Intended Learning Outcomes:
After attending the module, students will understand current topics in the psychology and economics of climate change. They are capable of applying online surveys to analyze the support or rejection towards climate policies and they can reference the relevant empirical evidence. Students can analyze the collected data with the appropriate statistical models. Students learn how to present scientific results in the public. In addition, students learn to write a term paper according to scientific standards.

Teaching and Learning Methods:
The lecture will be mostly done by presentations. In addition, articles from newspapers and journals are integrated into the lectures. Together with the lecturer, students will study the content and methods of the academic papers. In the exercises, the students themselves conduct an online survey and analyze the collected data. The results of the online survey are then presented and discussed individually and / or in groups from different perspectives by the students. Students will reproduce what has been learned in a written work.

Media:
Presentations, Articles

Reading List:
Drews, S., & Van den Bergh, J. C. (2016). What explains public support for climate policies? A review of empirical and experimental studies. Climate policy, 16(7), 855-876.
Bergquist, M., Nilsson, A., Harring, N., & Jagers, S. C. (2022). Meta-analyses of fifteen determinants of public opinion about climate change taxes and laws. Nature Climate Change, 12(3), 235-240.

Responsible for Module:
Pondorfer, Andreas; Prof. Dr.sc.pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Environmental Behavior and Support for Climate Policies (Vorlesung mit integrierten Übungen, 4 SWS)
Pondorfer A [L], Pondorfer A, Hoch G
For further information in this module, please click campus.tum.de or here.

Module Description

CS0239: Advanced Seminar in Environmental and Development Economics | Advanced Seminar in Environmental and Development Economics

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**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 seminar paper proving the ability of writing a scientific paper in the context of environmental and development economics and an oral presentation with discussion. The paper includes individual data analysis using econometric models as well as the discussion of the results and methods used. The seminar paper should cover 15-20 pages and is written in the style of a peer reviewed journal article. At the end of the module students present their work in a 30 minutes presentation. Weighting: Seminar paper 2, Presentation 1

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Advanced Development Economics, Advanced Environmental Economics, Advanced Empirical Research Methods

Content:
This advanced seminar focuses on recent developments in environmental and development economics. After being introduced to adequate research themes, students explore the academic literature on a chosen topic and develop their own research question. The topics are typically related to the assessment of interventions regarding determinants and causal relationships theoretically and empirically. Potential topics are:
- entrepreneurship
- agriculture
- migration - Environmental impacts of economic actions

Intended Learning Outcomes:
The objective of the module is to equip the participants with the necessary skill and tools for a successful master thesis project in the field of environmental and development economics.

Teaching and Learning Methods:
In an introductory session, the theme of the seminar is introduced and elaborated in detail. The introduction will also introduce the relevant literature in environmental and development economics. Based on the introduction, students will develop their own research question and decide on the adequate research methods. During the term students have to reach different milestones (e.g., choose a topic, choose a research method, collect data, outline their paper, write the paper, present the results) on specific dates. Following the submission of the seminar paper, students will present and discuss their research question and findings. During all stages of the seminar students will be assisted by the lecturer(s).

Media:
Research papers; presentation slides

Reading List:
Valerie Matarese (2013). Using strategic, critical reading of research papers to teach scientific writing: the reading–research–writing continuum, Editor(s): Valerie Matarese (2013). In Chandos Information Professional Series, Supporting Research Writing, Chandos Publishing,Pages 73-89. https://doi.org/10.1016/B978-1-84334-666-1.50005-9.)

Yongyan Li, Margaret Cargill, Xin Gao, Xiaoqing Wang, Patrick O'Connor (2019). A scientist in interdisciplinary team-teaching in an English for Research Publication Purposes classroom: Beyond a “cameo role”,
Journal of English for Academic Purposes, Volume 40, Pages 129-140. https://doi.org/10.1016/j.jeap.2019.06.005.

Yongyan Li, John Flowerdew (2020). Teaching English for Research Publication Purposes (ERPP): A review of language teachers’ pedagogical initiatives, English for Specific Purposes, Volume 59, Pages 29-41. https://doi.org/10.1016/j.esp.2020.03.002.

Responsible for Module:
Faße, Anja; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar in Environmental and Development Economics (Seminar, 4 SWS)
Faße A [L], Faße A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0239BOK: Law Basics; LE | Grundlagen des Rechts; VO

Version of module description: Gültig ab summerterm 2021

Module Level: Master	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

CS0240: Open Circular Innovation | Open Circular Innovation [OCI]

Innovation Challenges from an Industry Perspective

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** English	**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:
Individual presentation: Students will prove their understanding of opportunities and challenges in the field of circular economy. They show that they are able to put themselves into the situation of a specific company and quickly identify their focal circular economy topics.

Group presentation and group discussion (systemic circular innovation): Students will prove their understanding of systemic circular economy correlations and their ability to develop a feasible cross-value-chain concept. They understand different stakeholder perspectives and develop a strong argumentation line in a specific stakeholder role.

Group presentation (consulting pitch): Students will prove their ability to identify the need for circular economy analyses in a specific company and to propose a suitable open circular innovation approach. They show their skills to present a convincing consulting pitch in a power point presentation.

The students will be evaluated based on the following assignments:
- Individual presentation of a circular economy analysis in a specific industry (~10 min., based on a structured argumentation line, individual contribution evaluated) (20%)
- Group discussion in a stakeholder role play: conducting negotiations for a circular system innovation from a specific stakeholder perspective (~30 min., individual contribution evaluated) (20%)
- Group presentation and Q&A for a jointly developed circular system innovation (~30-45 min., based on a prototype model, group contribution evaluated, group size: ~5) (30%)
- Group presentation and Q&A for a circular innovation consulting pitch (~20-30 min., based on a power point slide deck, group contribution evaluated incl. submitted power point deck, group size: ~3-5) (30%)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students of this module should have passed the Bachelor Modules Circular Economy as well as Technology and Innovation Management.

Content:
The module contains units covering the following topics:
- Circular economy opportunities and challenges in different industries
- Circular economy strategy analysis
- Multiple lifecycle thinking
- Open circular innovation process
- Cross-value-chain circular systems
- Stakeholder negotiations
- Circular economy consulting pitch
- Industry deepdive for circular electronics
- Literature research and current trends/developments
- Case studies

Intended Learning Outcomes:
At the end of the module, the students are able to analyze strategic circular opportunities and challenges from a corporate perspective. They know different forms of open innovation and can evaluate their suitability for circular economy use cases in practice. Furthermore, they have gained an understanding of systemic correlations in a circular economy and can identify the conceptual circularity differences between industries.

The students know how to set up a cross-value-chain circular innovation approach and how to negotiate a circular solution from a specific stakeholder role. They are able to analyze circular opportunities from the perspective of a circular economy consultancy and can write and present a pitch for a circular innovation project.

The gained skills contribute to the students’ ability to conduct strategic circular economy analyses in industry, set up open circular innovation processes, and approach systemic circular economy solutions in practice.

Teaching and Learning Methods:
The module Open Circular Innovation transfers the theoretical knowledge of the module Circular Economy to practice and reflects the concept from the perspective of different industries. Students are able to connect the fields of circular economy and innovation management in a new dimension and prove their knowledge in practice-oriented circular innovation challenges.

Teaching / learning methods:
- Lectures on circular economy and open innovation

- Case reflections
- Academic and web research
- Workshop with group work on a systemic circular innovation concept
- Group work to build a prototype model for the systemic circular innovation concept
- Role play negotiations in a fictitious stakeholder group
- Workshop with group work on a circular economy consulting pitch
- Power point presentation
- Final group presentations

Media:
Power point, flipchart, online contents, online survey, case studies, prototype modeling, presentations

Reading List:
• Bocken, N. M. P., de Pauw, I., Bakker, C. A., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering, 33(5), 308–320. https://doi.org/10.1080/21681015.2016.1172124
• Chesbrough, H. W. (2003). Open Innovation: The new imperative for creating and profiting from technology. Harvard Business School Press.
• Chesbrough, H. W. (2006). Open innovation: A new paradigm for understanding industrial innovation. In H. W. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), Open innovation: Researching a new paradigm (pp. 1–12). Oxford University Press.
• Eisenreich, A., Füller, J., Stuchtey, M., & Gimenez-Jimenez, D. (2022). Toward a circular value chain: Impact of the circular economy on a company's value chain processes. Journal of Cleaner Production, 378, 134375. https://doi.org/10.1016/j.jclepro.2022.134375
• Eisenreich, A., Füller, J., & Stuchtey, M. (2021). Open circular innovation: How companies can develop circular innovations in collaboration with stakeholders. Sustainability, 13(23), 13456. https://doi.org/10.3390/su132313456
• Eisenreich, A., & Füller, J. (2023). You can't go circular alone – A stakeholder approach to circular innovation. Circular Economy, 1(1). https://doi.org/10.55845/HKKE5160
• Ellen MacArthur Foundation. (2013). Towards the circular economy: Economic and business rationale for an accelerated transition. https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an
• Ellen MacArthur Foundation. (2019). Artificial intelligence and the circular economy: AI as a tool to accelerate the transition. https://emf.thirdlight.com/file/24/GgC25OAGBvwdiFGgtzZGVXuZsz/Artificial%20intelligence%20and%20the%20circular%20economy.pdf
• Eapen, T. et al. (2023). How generative AI can augment human creativity. https://hbr.org/2023/07/how-generative-ai-can-augment-human-creativity
• Freeman, R. E., Harrison, J. S., & Zyglidopoulos, S. (2018). Stakeholder theory: Concepts and strategies. Cambridge University Press. https://doi.org/10.1017/9781108539500
• Govindan, K., & Hasanagic, M. (2018). A systematic review on drivers, barriers, and practices towards circular economy: A supply chain perspective. International Journal of Production Research, 56(1-2), 278–311. https://doi.org/10.1080/00207543.2017.1402141

• Füller, J., Hutter, K., & Faullant, R. (2011). Why co#creation experience matters? Creative experience and its impact on the quantity and quality of creative contributions. R&D Management, 41(3), 259–273. https://doi.org/10.1111/j.1467-9310.2011.00640.x

Responsible for Module:
Prof. Magnus Fröhling

Courses (Type of course, Weekly hours per semester), Instructor:
Open Circular Innovation (Lecture) (Vorlesung, 2 SWS)
Fröhling M [L], Eisenreich A

Seminar Open Circular Innovation (Seminar, 1 SWS)
Fröhling M [L], Eisenreich A, Fröhling M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0240BOK: Practical course in measurement systems and applied programming (in Eng.); PR | Practical course in measurement systems and applied programming (in Eng.); PR

Version of module description: Gültig ab summerterm 2021

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

CS0241: Excursion Circular Economy & Sustainability | Excursion Circular Economy & Sustainability

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** irregularly
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:
Passed/not passed: Participation in total excursion; 10-15 min preparatory keynote; 1-2 written pages reflection after excursion

Repeat Examination:

(Recommended) Prerequisites:
Participation in the excursion is linked to registration and participation in the "Advanced Seminar in Circular Economy and Sustainability Management" or to use the research results of the excursion in a Master Thesis (to be discussed prior with the module responsible)

Content:
12-day excursion to Ghana to carry out the necessary scientific works for the seminar or the master thesis with student keynotes on cultural topics as preparation and written reflection after arrival. Visiting hot spots of ecological challenges and stakeholders actively contributing towards more sustainable behavior. Engaging with locals for on-site research.

Intended Learning Outcomes:
The excursion aims to support the profile building and the acquisition of scientific and social competencies. The main focus is to create and gain first-hand insights on Circular Economy topics in Ghana and to counteract the habit of talking from a Northern perspective about the challenges of the Global South. By participating in the excursion, students should be enabled to acquire in-depth knowledge on the seminar topics offered within the "Circular Economy in the Global South, the case of Ghana" on-site and firsthand.
The students will get insights into the diverse and rich Ghanaian culture, which will further enhance their understanding of global Circular Economy challenges.

By performing on-site field research to collect primary data, they will develop solution approaches to closing resource loops and establish contact with locals.

Teaching and Learning Methods:
Excursion: after a kick-off session and several introductory lectures, the students will carry out literature research on cultural and travel-relevant aspects related to Ghana. They summarize their findings in an oral keynote. In this process, they are supervised, receive materials, thematic introductions, and continuous feedback. After returning from the excursion, they will reflect upon their learnings in written form.

Teaching/learning methods:
- Kick-off session
- Lectures
- Individual work and feedback
- Presentation
- On-site visits
- Workshops
- Exchange with locals

Media:
Digital projector, board, flipchart, online contents, recent scientific journal publications

Reading List:
Topic related reading, especially articles in international peer reviewed journals, will be provided in the kick-off meeting and lectures of the module.

Responsible for Module:
Magnus Fröhling

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

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

Module Description

CS0241BOK: Statistics (LBT); LE | Statistik (LBT); VO

Version of module description: Gültig ab summerterm 2021

Module Level: Master	Language:	Duration:	Frequency:
Credits:* 2	**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

CS0242: Foundations of Biology | Foundations of Biology [FBio]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** English	**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 learning results are proved in a written test in which the students are to call up and remember important principles of biology without using additives. In addition, the students prove that they are able to recognize and solve a problem in a certain time by answering the comprehension questions on covered biological processes. Answering questions requires also the use of own formulations thereby the correct recall of important technical terms is additionally reviewed. Exam duration: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Chemical building blocks of life; Basics of cell biology (cell structure, differences between pro- and eukaryotic organisms, theoretical basics of microscopy); genetic information flow and fundamentals of genetics (e.g. structure of DNA, replication, transcription, translation, Mendelian genetics); basic metabolic processes; evolution and systematics of organisms; introduction to plant sciences; introduction to microorganisms and their use in industrial biotechnology; introduction to molecular biotechnology and genetic engineering; concepts of ecology and sustainability

Intended Learning Outcomes:
After having participated in the module the students possess basic knowledge about the structure and function of biomolecules. They know important elements of pro- and eukaryotic cells, can differentiate between these life forms and grade microorganisms and plants to higher-ranking systematic groups. They know the concepts of the genetic flow of information and have a basic knowledge of the most important techniques in molecular biology.CXao

the participants know fundamental metabolic pathways and have a basic understanding of microbial and plant physiology. Furthermore, the students can reflect biological terms, define processes and are able to use their knowledge to solve problems.

Teaching and Learning Methods:
The teaching contents are imparted by a talk of the lecturer, supported by PowerPoint and blackboard sketches. To a limited extent small exercises are integrated.

Media:
Power point, blackboard

Reading List:
"Campbell Biologie" by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Pearson, 11th edition (2019)

Responsible for Module:
Glawischnig, Erich; Prof. Dr. rer. nat. 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

CS0242BOK: Technical Drawing with CAD; LEE | Technisches Zeichnen mit CAD; VU

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**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

CS0243: Practical Course Electrobiotechnology | Praktikum Elektrobiotechnologie [EBTP]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 75	**Contact Hours:** 105

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

Description of Examination Method:
The assessment is done in the form of protocols of the laboratory experiments carried out (7 laboratory experiments per experiment 2-3 pages protocol). In these, the students have to evaluate the data obtained in the practical experiment and compare it with the predictions of the underlying theoretical model. The evaluation and discussion of the results are recorded in the protocol together with the correct description of the experimental procedure. In this way, the students should prove that they are able to understand the theoretical basis of the experiment, document their experimental performance, evaluate and discuss the measurement data obtained. The submitted protocols are graded according to completeness, correctness and comprehensibility/clearness, whereby a one-time correction of the protocols is possible. The protocol is considered passed if the criteria are fulfilled by more than 50%, consequently 4.0 or better.
The module is considered passed if all protocols are passed. In this case, the grade for the module results from the averaged grades of the protocols, i.e. (sum grade protocol 1-7)/7.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful participation in the module " Einführung in die Elektrochemie " as well as " Praktikum Allgemeine Chemie" and " Praktikum Biochemie ". In addition, knowledge of grammar school English.

Content:
During the block practical, several electrochemical experiments are carried out to characterise the active components. On the next day, the measurement results obtained are analysed together and compared with simulations of known models. On the basis of this, kinetic parameters are to

be determined (e.g., catalytic rate and Michaelis-Menten constant) as well as limits of the known models and sources of error are to be shown. The model systems used for this purpose are:
• Determination of the electrode surface by means of capacitive and potentiometric measurements.
• Voltammetry of freely diffusing redox mediators.
• Voltammetry of redox-active enzymes in solutions by mediated electron transfer.
• Measurement of glucose concentration by electrochemical methods.
• Voltammetry of redox-active enzymes immobilised on electrodes.
• Determination of the faradaic efficiency of biocatalytic NADP+ reduction using an FNR/V++ PVA-modified electrode.

Intended Learning Outcomes:
After successful participation in this module, the students are able to:
• handle electrochemical apparatus safely (potentiostats, electrochemical cells).
• carry out electrochemical measurements of biocatalytic systems (prepare the electrodes, set up a measuring apparatus and carry out potentiometric and voltametric measurements).
• analyse the measurement results obtained and determine kinetic and other parameters based on them.
• to use simulation software to obtain possible reaction mechanisms from the measurement data.
• to recognise sources of error in electrochemical experiments and to adapt the experiment.

Teaching and Learning Methods:
In the laboratory, the students learn the fundamentals of electrochemistry by carrying out experiments independently. In the process, students are directly supervised in small groups. In order to also gain a theoretical understanding of the underlying mechanisms and to learn the methods for analysing electrochemical measurement data, the analysis of the previously obtained data is carried out together. The theory is first discussed and then applied individually. Simple simulations are then carried out and the measurement results are compared quantitatively with the theory.
This inclusive approach should enable the knowledge to be conveyed as practically as possible, so that the students are then able to plan and carry out experiments independently and generate knowledge from them.

Media:
Slides, script, film, simulation software

Reading List:
Electrochemical Methods: Fundamentals and Applications; Bard/Faulkner, ISBN-13: 978-0471043720

Responsible for Module:
Prof. Nicolas Plumeré

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum Elektrobiotechnologie (Praktikum, 7 SWS)

Plumeré N [L], Ahmed M, Höfer T, Honacker J, Jaenecke J, Moore Y, Plumeré N
For further information in this module, please click campus.tum.de or here.

Module Description

CS0244: Inventory and Transportation Management | Inventory and Transportation Management

Version of module description: Gültig ab winterterm 2023/24

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:
Written exam: 60 minutes written exam on presentation, recommended readings, and case studies

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Bachelor Business administration; advanced knowledge of Mathematics, Statistics and Operations Research

Content:
The course covers decision-oriented aspects of logistics and discusses basic concepts, models, and methods for inventory management and transportation planning in supply chains. This course content provides the foundation for a critical examination of logistics systems from a theoretical and practical perspective.

Part A: Introduction
▪ Terminological Issues of Logistics Management
▪ Principles of Logistics Management

Part B: Inventory Management
▪ Basics of Inventory Management
▪ Lot Sizing
▪ Safety Stock
▪ Work-in-Process

Part C: Transportation Management

▪ Basic Methods for Transport Optimization
▪ Transportation Planning
▪ Packaging
▪ Shortest Rout Problems
▪ Traveling Salesman and Vehicle Routing

Intended Learning Outcomes:
The students:
- know the conceptual structure of inventory management and transportation planning and understand basic concepts, models, and methods that are applied in industry and logistics applications
- gain experience in the logistics using prevalent decision models, software systems and understand scope and limitations in supporting practical decision situations.
- hone their skills with respect to modeling and solving decision problems in logistics management.

Teaching and Learning Methods:
Lecture (theory), tutorials with group work and presentation

Media:
Seminaristic delivery using beamer, overhead projector, flipchart

Reading List:
Chopra/Meindl (2009): Supply Chain Management: Strategy, Planning, and Operation, Global Edition
Ghiani, G., Laporte, G., Musmanno R. (2013), Introduction to Logistics Systems Management, 2. edition, Wiley
Günther, H.O., Tempelmeier, H. (2020), Supply Chain Analytics
Silver, E. A., Pyke, D. F. und R. Peterson, Inventory Management and Production Planning and Scheduling, 3. edition, New York (Wiley) 1998.

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Inventory and Transportation Management (Lecture) (Vorlesung, 2 SWS)
Hübner A [L], Hübner A

Inventory and Transportation Management (Exercise) (Übung, 2 SWS)
Hübner A [L], Riesenegger L
For further information in this module, please click campus.tum.de or here.

Module Description

CS0245: Advanced Electronic Spectroscopy | Advanced Electronic Spectroscopy

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:** 90	**Contact Hours:** 60

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

Description of Examination Method:
The performance test will be in the form of a written examination. The students should demonstrate in the exam the understanding of the different techniques taught during the module.
No auxiliary means are allowed in the exam. 120 min examination time

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
This course will intend to consolidate concepts in Physics, Chemistry, and Instrumentation having the focus on articles utilizing the different techniques. As such, knowledge in Physics, Chemistry, and Instrumentation is required.

Content:
The module aims to provide in-depth knowledge to the students in electronic spectroscopy and its applications.
The module will critically evaluate optical spectroscopy techniques such as fluorescence, Uv-Vis absorption, Circular dichroism, photoacoustic spectroscopy, and circularly polarized luminescence focusing on their fundamental strength and weakness. Every method will be described following three main focuses: theory, material description, and applications.
Application examples will be from literature and journal articles.
The module will also continuously reinforce the theoretical background of the interaction between electromagnetic radiation and matter.

Intended Learning Outcomes:
At the end of the module, the students will have developed the ability to analyze advanced problems in electronic spectroscopy and associated phenomena. They will learn to evaluate

critically information regarding techniques such as fluorescence, Uv-Vis absorption, Circular dichroism, photoacoustic spectroscopy, and circularly polarized luminescence.

Teaching and Learning Methods:
This course attendance includes lectures and exercises. Additionally, in the module's final weeks, the student will be encouraged to create a presentation consisting of their critical analysis of a journal article. For this purpose, PowerPoint presentations, practical training materials, and open discussion seminars will be used.

Media:
The following forms of media apply Script, PowerPoint, films, and blackboards.

Reading List:
1. Physical Chemistry for the Life Sciences, 2ndEdition Peter Atkins and Julio De Paula Oxford University Press ISBN: 978-0-19-956428-6
2. Introduction to Biophotonics Paras N. Prasad Wiley 2003, ISBN: 0-471-28770-9.
3. Principles of fluorescence spectroscopy , Lakowicz, Joseph R., ed. . Springer science & business media, 2013.

Responsible for Module:
Costa Riquelme, Rubén Dario; 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

CS0246: Practical Research Experience | Practical Research Experience

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**Language:** English	**Duration:** one semester	**Frequency:** winter/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:
Grading is based on a project work. The project work consists of a written project report. The student works on a specific problem set. The student runs through several project stages: problem definition, division of work/tasks, decision making processes, and realization. Throughout this process, the student shows that she/he can develop appropriate strategies to cope with the set of problems. She/he shows the ability able to compose the state of research. In addition she/he demonstrates the ability to develop their own specific approach for a solution based on scientific knowledge as well as methodical skills.
Grading will especially take into account the overall working outcome of the project with respect to the initial problem set, the selection and application of the chosen methodology as well as the analyses and discussion of the main findings. The project work is set up in a way which enables the identification and evaluation of each student's individual contribution to the project's success.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in Business Administration and Management
Management Science (CS0075)
Sustainable Operations (CS0196)
Case Study Seminar in SCM (CS0080)

Content:
The research study consists of a specific problem statement or challenge. This challenge may have a research related or practical character. The research project and its findings regarding the outlined problem set are based on students' academic knowledge gained through their Bachelor study programs. Examples of topics covered in the context of a include (non-exhaustive list) for

example analyzing potential sales volumes with data mining techniques, identifying potential optimization actions or applying algorithms for certain business problems.

Intended Learning Outcomes:
After successful participation in the module, students obtain basic knowledge to work on research projects in an academic manner. Students understand on how to complete a research project in particular in identification research gaps, developing research questions, selecting appropriate research methods and apply them to actual research problem. Students obtain capabilities to deepen and apply theoretical concepts to the identified problem set and apply analytical solution finding skills. Students become able to manage resources, and deadlines through timely submission of the enumerated tasks in stages throughout their research projects.

Teaching and Learning Methods:
The development of the solution of the research question encourages the students to deal soundly with an academic subject based on their previously acquired academic knowledge. The project may happen at the premises of a respective company/institution or from a remote location. Participants are able to communicate the evolvement of the project by composing a project report and preparing a presentation of their solutions to the supervisors. With regards to content the research study takes an approximate time of 12-14 weeks.

Media:
literature, presentations

Reading List:
Project Management Institute (2013): A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fifth Edition
Further literature based on the specific topic

Responsible for Module:
Prof. Alexander Hübner

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

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

Module Description

CS0248: Markets for Renewable Energies and Biobased Products | Märkte für erneuerbare Energien und biobasierte Produkte

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 exam performance is effected by a written test. Through comprehension questions it is reviewed whether the students have understood principles of market development in the covered markets. The students answer questions regarding the development and current situation on the markets of renewable energies and biogenic products as well as the most important factors that influence this market development. The students prove that they have understood the interest and behaviour of actors being active on these markets by answering corresponding questions.
Exam duration: 90 minutes.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic know-how to the functioning of markets

Content:

A) Introduction and overview

B) Markets for renewable energies
- Regenerative electricity
- Regenerative heat /cooling
- Sustainable mobility
- Sector coupling

C) Markets for biobased products
- Chemical markets

- Building & Living
- Biomaterials
- Other markets (e.g. paper, cardboard, carton, natural cosmetics)

Intended Learning Outcomes:
After attending the module, students will be able to show the developments of markets for energy and biobased products and discuss market development. Students are familiar with the relevance, size, and important influencing factors on the renewable energy markets as well as markets for material use of biogenic resources. They are able to compare these markets, to capture important determinants of market development, and to identify the use of fossile and regenerative energies as well as the use of biomass for material applications in a macroeconomic and societal context thus developing strategies for future use.

Teaching and Learning Methods:
The lecture will be done using Powerpoint with specifically worked out presentation scripts. In addition, published studies and statistical data related to the development and situation on the targeted markets will be integrated into the lectures. Furthermore, current topics are discussed with students.

Media:
Slide presentation, Lecture recordings; Interactions using Moodle; selected journal articles; current topic-related news, videos

Reading List:
Quaschning, Volker (2020): Erneuerbare Energien und Klimaschutz: Hintergründe – Techniken und Planung – Ökonomie und Ökologie – Energiewende. 5. Auflage. Hanser Verlag: München.

FNR (2014): Marktanalyse Nachwachsender Rohstoffe. Schriftenreihe Nachwachsender Rohstoffe 34. Gülzow.

Responsible for Module:
Thomas Decker

Courses (Type of course, Weekly hours per semester), Instructor:
Märkte für erneuerbare Energien und biobasierte Produkte (Vorlesung, 4 SWS)
Menrad K [L], Decker T, Emberger-Klein A, Menrad K
For further information in this module, please click campus.tum.de or here.

Module Description

CS0250: Research Internship STM A | Research Internship STM A

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 75	**Contact Hours:** 45

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

Description of Examination Method:
Exam achievement consists of a graded practical course report about contents and results of the practical course containing at least an overview of the level of knowledge relating to the project subject as well as representation of used working methods and a representation of the results including interpretation. In a final grade quality of familiarisation with the topic of experimental work, interpretation of results and written elaboration shall be evaluated.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Research-related works at the chairs and working groups of the TUMCS. The students shall each get tasks from the research field of the mentoring examiner. They shall work on these tasks under supervision in form of projects. Topics have to be allocated with regard to content and expertise to the material sciences. The students shall largely independently plan project works under supervision of the mentors. Project works shall be documented and evaluated in form of an internship report. Optionally a completing presentation of work progress may be done in form of oral presentations. Project works can also be done in cooperation with external institutions, e.g. companies.

Intended Learning Outcomes:
After having participated in the module the students especially understand principles of approach to (research) projects, planning of project works and critical evaluation of project results beside subject-specific knowledge and working methods each imparted in the practical course in scientific working. The students will be able to apply these principles to new project tasks. Besides they are

able to document, to interpret and summarise project works and results in a meaningful way in written form.

Teaching and Learning Methods:
According to the core theme and topic, e.g. experimental equipment (laboratory), databases, libraries, subject-specific software, project and experiment design software

Media:
According to the topic, e.g. experimental equipment (laboratory), databases, libraries, subject-specific software, project and experiment design software

Reading List:
Technical literature related to mentioned topics

Responsible for Module:
Prof. Cordt Zollfrank

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

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

Module Description

CS0251: Research Internship STM B | Research Internship STM B

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 75	**Contact Hours:** 45

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

Description of Examination Method:
Exam achievement consists of a graded practical course report about contents and results of the practical course containing at least an overview of the level of knowledge relating to the project subject as well as representation of used working methods and a representation of the results including interpretation. In a final grade quality of familiarisation with the topic of experimental work, interpretation of results and written elaboration shall be evaluated.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Research-related works at the chairs and working groups of the TUMCS. The students shall each get tasks from the research field of the mentoring examiner. They shall work on these tasks under supervision in form of projects. Topics have to be allocated with regard to content and expertise to the material sciences. The students shall largely independently plan project works under supervision of the mentors. Project works shall be documented and evaluated in form of an internship report. Optionally a completing presentation of work progress may be done in form of oral presentations. Project works can also be done in cooperation with external institutions, e.g. companies.

Intended Learning Outcomes:
After having participated in the module the students especially understand principles of approach to (research) projects, planning of project works and critical evaluation of project results beside subject-specific knowledge and working methods each imparted in the practical course in scientific working. The students will be able to apply these principles to new project tasks. Besides they are

able to document, to interpret and summarise project works and results in a meaningful way in written form.

Teaching and Learning Methods:
According to the core theme and topic, e.g. experimental equipment (laboratory), databases, libraries, subject-specific software, project and experiment design software

Media:
According to the topic, e.g. experimental equipment (laboratory), databases, libraries, subject-specific software, project and experiment design software

Reading List:
Technical literature related to mentioned topics

Responsible for Module:
Prof. Cordt Zollfrank

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

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

Module Description

CS0251BOK: Description, Functions of Soil Structure and its Changes in Agricultural Landuse | Description, Functions of Soil Structure and its Changes in Agricultural Landuse

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
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

CS0252: Project on Public Discourses and Scientific Solutions | Projekt zu öffentlichen Diskursen und wissenschaftlichen Lösungen

Project on Public Discourses and Scientific Solutions

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor	**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 examination takes the form of a poster presentation followed by a discussion. The group (max. 5 students) designs a scientific poster on the topic covered. After a short presentation of the poster (total duration: 30 minutes depending on group size; approx. 6 minutes per student), there will be a discussion on the topic and the content of the poster (total duration: 50 minutes depending on group size; approx. 10 minutes per student). Each group member will be asked individual questions. The design, presentation and content of the poster (70 %) and the appropriate answers to the individual questions (30 %) are assessed and form the final grade.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
First four semesters of Bioeconomy ;-)

Content:
In the public debate, current topics from areas such as bioeconomy, sustainability, the energy transition and the mobility transition are widely discussed. Often, "science" is invoked to lend more weight to arguments. Unfortunately, the scientific findings are often abbreviated or selectively reproduced. In this project, groups will deal with current topics from the public debate and try to use their interdisciplinary background to provide a scientific perspective. Which arguments are accurate? Which arguments are false or one-sided? Does science provide universally appropriate solutions to the discussed issue or are solutions depend on different objectives?

Intended Learning Outcomes:
After successfully completing the module, students are able to

- work together in teams with heterogeneous knowledge and backgrounds.
- combine the interdisciplinary skills learned in the Bioeconomy degree program and apply them to a topic.
- present and communicate scientific evidence clearly
- analyze and evaluate scientific arguments in political debates
- identify abbreviated representations of scientific evidence.

Teaching and Learning Methods:
In the project, Bachelor and Master students work together cooperatively on a topic. The team size is 3-6 people, depending on the task. The Master's students coordinate the groups, formulate interim goals together with the Bachelor's students and are responsible for achieving them. The Bachelor's students carry out the scientific research on the topics and summarize the current status from the perspective of various disciplines. They are supported in this by the Master's students. In regular meetings with the lecturers, questions about the scientific literature, the general procedure, and timelines are answered.

Media:
Newspaper articles, radio, TV reports, scientific publications, PowerPoint presentations, posters

Reading List:
Additional literature will be provided based on the current topics covered in the semester.

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

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

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

Module Description

CS0252BOK: Priniciples of Commodity Markets and Trade Policy | Priniciples of Commodity Markets and Trade Policy

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
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

CS0253: Accredited Module 8 ECTS | Anerkanntes Modul 8 ECTS

Version of module description: Gültig ab winterterm 2021/22

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 8	**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

CS0253-2: Accredited Module 8 ECTS | Anerkanntes Modul 8 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 8	**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

CS0253-3: Accredited Module 8 ECTS | Anerkanntes Modul 8 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 8	**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

CS0253-4: Accredited Module 8 ECTS | Anerkanntes Modul 8 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	Language:	Duration:	Frequency:
Credits:* 8	**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

CS0253-5: Accredited Module 8 ECTS | Anerkanntes Modul 8 ECTS

Version of module description: Gültig ab summerterm 2023

Module Level:	Language:	Duration:	Frequency:
Credits:* 8	**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

CS0254: Introduction to Economics of Renewable Resources | Introduction to Economics of Renewable Resources [IntroEconRES]

Version of module description: Gültig ab winterterm 2023/24

Module Level:	**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 is a written exam (120 minutes). The students demonstrate that, within a limited time and without tools, the economic relationships involved in the use of renewable raw materials have been understood and can be analyzed and further developed in connection with individual company activities. The exam also examines the extent to which the students can characterize the various markets for renewable raw materials and show possible solutions for material and energetic use.

The lecture and exercise "Economics of Renewable Resources" accounts for 65% and the lecture "Markets for Renewable Resources" for 35% of the overall grade.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
None

Content:
The lecture is divided into 3 parts. Although these are independent of each other in terms of content, they address different facets of the economy of renewable resources.

1. Lecture Economics of Renewable Resources
Introduction to the basics of economics using selected conversion paths based on renewable raw materials, from location decisions to procurement and logistics, production, inter-company connections to external reporting.

2. Lecture Markets of Renewable Resources

Presentation of different markets for renewable raw materials. These are divided into material use (bio-lubricants, materials, base chemicals and fine chemicals) and energetic use (heat, electricity and mobility).

3. Exercise Economics of Renewable Resources
The content of the lecture is to analyze and critically evaluate the economics of renewable resources using case studies, so that the participants can independently develop the content further based on the content of the lecture.

Intended Learning Outcomes:
After completion of the module, the students can apply the economic principles of using renewable raw materials in a differentiated manner and analyze and evaluate the economics using case studies from individual companies. Furthermore, they are able to critically assess the business and market relationships in the utilization of renewable raw materials and to include current developments. In addition, the students can assess and compare the different forms of marketing and market sizes of renewable raw materials.

Teaching and Learning Methods:
Lecture; discussions; case studies
With the help of the lectures and exercises, all sub-areas of the module are presented. With the help of this method, the extensive volume of material can be communicated in the best way. In the discussions, the students learn to integrate different perspectives and to correctly classify and critically assess the module content.

Media:
Presentations, script, case studies

Reading List:
Wacker, H., Blank, J. E.: Ressourcenökonomie, Bd. 2 Einführung in die Theorie erschöpfbarer natürlicher Ressourcen, München, Oldenbourg Verlag, 1999.;
KALTSCHMITT, M. und H. HARTMANN (Hrsg.): Energie aus Biomasse. Grundlagen, Techniken und Verfahren. Springer Berlin, 2009;
Vahs, D., Schäfer-Kunz, J.: Einführung in die Betriebswirtschaftslehre. Schäffer-Poeschel Verlag Stuttgart. 2012

Responsible for Module:
Röder, Hubert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Overview Markets of Renewable Resources (Lecture) (Vorlesung, 1,5 SWS)
Decker T

Management of Renewable Resources (Exercise) (Übung, 1 SWS)
Röder H

Management of Renewable Resources (Lecture) (Vorlesung, 1,5 SWS)
Röder H [L], Pokholkova M, Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0254: Introduction to Management of Renewable Resources | Introduction to Management of Renewable Resources

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 is a written exam (120 minutes). The students demonstrate that, within a limited time and without tools, the economic relationships involved in the use of renewable raw materials have been understood and can be analyzed and further developed in connection with individual company activities. The exam also examines the extent to which the students can characterize the various markets for renewable raw materials and show possible solutions for material and energetic use.

The lecture and exercise "Economics of Renewable Resources" accounts for 65% and the lecture "Markets for Renewable Resources" for 35% of the overall grade.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The lecture is divided into 3 parts. Although these are independent of each other in terms of content, they address different facets of the economy of renewable resources.

1. Lecture Economics of Renewable Resources
Introduction to the basics of economics using selected conversion paths based on renewable raw materials, from location decisions to procurement and logistics, production, inter-company connections to external reporting.

2. Lecture Markets of Renewable Resources

Presentation of different markets for renewable raw materials. These are divided into material use (bio-lubricants, materials, base chemicals and fine chemicals) and energetic use (heat, electricity and mobility).

3. Exercise Economics of Renewable Resources
The content of the lecture is to analyze and critically evaluate the economics of renewable resources using case studies, so that the participants can independently develop the content further based on the content of the lecture.

Intended Learning Outcomes:
After completion of the module, the students can apply the economic principles of using renewable raw materials in a differentiated manner and analyze and evaluate the economics using case studies from individual companies. Furthermore, they are able to critically assess the business and market relationships in the utilization of renewable raw materials and to include current developments. In addition, the students can assess and compare the different forms of marketing and market sizes of renewable raw materials.

Teaching and Learning Methods:
Lecture; discussions; case studies
With the help of the lectures and exercises, all sub-areas of the module are presented. With the help of this method, the extensive volume of material can be communicated in the best way. In the discussions, the students learn to integrate different perspectives and to correctly classify and critically assess the module content.

Media:
Presentations, script, case studies

Reading List:
Wacker, H., Blank, J. E.: Ressourcenökonomie, Bd. 2 Einführung in die Theorie erschöpfbarer natürlicher Ressourcen, München, Oldenbourg Verlag, 1999.;
KALTSCHMITT, M. und H. HARTMANN (Hrsg.): Energie aus Biomasse. Grundlagen, Techniken und Verfahren. Springer Berlin, 2009;
Vahs, D., Schäfer-Kunz, J.: Einführung in die Betriebswirtschaftslehre. Schäffer-Poeschel Verlag Stuttgart. 2012

Responsible for Module:
Röder, Hubert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Overview Markets of Renewable Resources (Lecture) (Vorlesung, 1,5 SWS)
Decker T

Management of Renewable Resources (Exercise) (Übung, 1 SWS)
Röder H

Management of Renewable Resources (Lecture) (Vorlesung, 1,5 SWS)
Röder H [L], Pokholkova M, Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0255: Current Topics in Machine Learning and Bioinformatics | Current Topics in Machine Learning and Bioinformatics [CTMLBI]

Version of module description: Gültig ab summerterm 2023

Module Level: 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:
The learning outcomes are tested by a graded seminar presentation with a duration of approximately 45 minutes including a discussion with the audience. The seminar allows the students to assess the extent to which they can summarize a complex scientific work in the field of Machine Learning or Bioinformatics correctly and present it to an audience in a comprehensible and convincing way. Furthermore, to assess the skill to quickly understand, review and critically discuss recent research in these fields, the active participation and discussions of the other seminar presentations will be considered as well.

Repeat Examination:

(Recommended) Prerequisites:
Knowledge in Machine Learning and Bioinformatics (e.g. Bioinformatics (WZ1631) and Artificial Intelligence for Biotechnology (CS0012)) is expected

Content:
At the beginning of this course, introductory lectures about current topics in Machine Learning and Bioinformatics will be given. The following topics are treated exemplarily:
- Ensemble learners
- Neural Networks (Basic concept, Feedforward neural networks, Recurrent Neural Networks, Convolutional Neural Networks, Generative Models)
- Green Artificial Intelligence
- Genome-wide Association Studies
- Phenotype Prediction
- Protein-Protein Interaction Network Analysis
- Protein Prediction

- Data Driven Biotechnology
In this course, we will also talk about recent Machine Learning and Bioinformatics research and how it can support sustainability, e.g., by guiding downstream research with data-driven approaches. Furthermore, we will also look at Green Artificial Intelligence, a research direction that aims to make resource-intense AI development more sustainable. After introductory lectures, each student will analyze a recent scientific paper in these research areas in self-study and present it to the course. Active participation and discussions in all the other presentations is expected.

Intended Learning Outcomes:
After successful participation in this module, students will be able to understand and present recent research in Machine Learning or Bioinformatics. They are enabled to analyze recent scientific publications in one of the two fields. Based on this knowledge, they can summarize and present a scientific paper in a concise and understandable way as well as to discuss recent research in Machine Learning or Bioinformatics. Furthermore, students know about current research directions in these scientific fields and know how current Machine Learning and Bioinformatics research supports sustainability.

Teaching and Learning Methods:
At the beginning of this course, introductory lectures to current Machine Learning and Bioinformatics topics will provide additional and necessary fundamentals to understand recent scientific publications. Furthermore, each student will analyze a recent research paper in one of the two fields in self-study and present it to the course to train the ability to understand advanced concepts. Beyond that, for further training of these skills, the paper presentations will be discussed in the course.

Media:
Slide presentation, blackboard, discussion forums in e-learning platforms

Reading List:
Pattern Recognition and Machine Learning, Christopher M. Bishop
Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville

Responsible for Module:
Prof. Dr. Dominik Grimm, Florian Haselbeck

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

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

Module Description

CS0256: Innovation Management | Innovation Management [Innovation and Technology Management]

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**Language:** English	**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:
The grading will be based on a written exam (60 min). By answering multiple choice questions students have to show that they have understood and can apply models and concepts related to markets aspects of innovation and to the organization of the innovation process. The questions may require calculations.
Students may use a nonprogrammable calculator to do these calculations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
Market aspects of innovation:
Innovation: Examples and particularities,
Innovation and the development of industries,
Sources of innovation,
Innovation strategy: Analysis of the market, technology and competition,
Acquisition of technology: Market, cooperation and networks

Organizing the innovation process:
The innovation process within the firm,
R&D, production and marketing,
Cooperation for innovation,
Motivation and incentive systems,
Promotors and champions,

Roles in the innovation process,
Opposition against innovation within the firm,
Integrating customers into the innovation process,
Measuring and controlling innovation.

Intended Learning Outcomes:
At the end of the module, students will be able to (1) recognize and apply models and concepts related to the market aspects of innovation (e.g., modes of acquisition of technology) and to the organization of the innovation process (e.g., promotors and champions in the innovation process), (2) identify how they can be concretely used in companies and in the context of green innovation.

Teaching and Learning Methods:
The module consists of lectures including one or two sessions held by guest speakers to refer to state of the art examples of green innovation. Students will be motivated to read the literature before and after each lecture and relate it to the content taught in class. Furthermore, they will be motivated to discuss the content in online forums that are made available to the students.

Media:
Lecture slides are available via Moodle. Presentation slides, online discussion forum

Reading List:
Afuah Innovation Management. strategies, implementation, and profits
Dodgson, Gann, Salter The Management of Technological Innovation (Chapter 4)
Teece Profiting from Technological Innovation: Implications for integration, collaboration, licensing and public policy
Stamm Structured Processes for Developing New Products
Hauschildt, Kirchmann Teamwork for innovation the ""troika"" of promotors

Responsible for Module:
Doblinger, Claudia; Prof. Dr. rer. pol. 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

CS0257: Molecular Biology and Genetics | Molekularbiologie und Gentechnik [MolBio]

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 8	**Total Hours:** 240	**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:
The performance of the exam consists of a written test (90 min) in which the students show that they are able to call up and structure their theoretical and practical knowledge and use it on problems. By creating written protocols of the executed laboratory experiments (for each experiment about 5 pages of protocol), the students prove that they can documentate and illustrate theoretical principles as well as the results and the corresponding analysis and assessment of the experiments (not graded course achievement).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successfully completed exam for the Cell- and Microbiology module (CS0256) or an equivalent module. As a prerequisite for participation in the practical course, the written examination for the lecture must be successfully passed.

Content:
molecular structure of DNA, plasmids, bacteriophages, mutagenesis strategies, bacterial genomes, prokarotic gene regulation, transformation of organisms, genetic engineering, genetic engineering regulation, genome editing, cloning of DNA fragments, heterologous gene expression, analysis methods for DNA, RNA and proteins

Intended Learning Outcomes:
After completion of the modul the students possess knowledge about the most important molecular biological methods. They know how to isolate, analyse and manipulate nucleic acids and possess knowledge about the transformation of microorganisms. They understand what a genetically engineered organism is and can assess the risks and benefits of genetic engineering experiments,

including the benefits of new transgenic strains for sustainable production processes. The students can perform and analyse molecular biological experiments and name possible sources of error.

Teaching and Learning Methods:
The theoretical basics of the experiments conducted in the practical course will be delivered in the lecture part via ppt-presentations, movies and white board. In the practical course, the students will self-reliantly perform, document and analyse their experiments.

Media:
PowerPoint, blackboard work, practical course script

Reading List:
Molekularbiologische Methoden 2.0, T. Reinard, Utb, 2. Auflage, ISBN: 978-3-8252-8742-9
Mikrobiologie, J. L. Slonczewski, J. W. Foster, Springer Spektrum, 2. Auflage, ISBN: 978-3-8274-2909-4
Genome und Gene, T. A. Brown, Spektrum, 3. Auflage, ISBN: 978-3-8274-1843-2
Gentechnische Methoden, M. Jansohn, S. Rothhämel, Springer Spektrum, 2. Auflage, ISBN: 978-3-8274-2429-7
An Intro to Genetic Engineering, Desmond S. T. Nicholl, 3ed., Cambridge University Press, ISBN: 978-0521615211

Responsible for Module:
Prof. Dr. Bastian Blombach

Courses (Type of course, Weekly hours per semester), Instructor:
Molekularbiologie und Gentechnik (Vorlesung) (Vorlesung, 2 SWS)
Blombach B [L], Blombach B

Molekularbiologie und Gentechnik (Praktikum) (Praktikum, 4 SWS)
Blombach B [L], Blombach B, Glawischnig E, Hädrich M, Vital S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0258: Nawaro in Communication and Didactics | Nawaro in Kommunikation und Didaktik

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:
Im Laufe des Semesters wird von den Studierenden als Studienleistung die Ausarbeitung von Präsentationen, Teilnahme an Rollenspielen und Fallbearbeitungen in der Gruppe mit Videoanalysen erwartet (unbenotet). Die benotete Prüfungsleistung wird in zwei Teilen erbracht. Der erste Teil ist eine bewertete Lehrveranstaltung (Präsentation: 20 min) in Gymnasien und anderen weiterführdenen Schulen, bei der die erworbenen didaktischen Fähigkeiten angewendet werden sollen (80 % der Note). Der zweite Teil der Prüfung besteht aus einem schriftlichen Bericht (ca. 10 Seiten) bezüglich der durchgeführten Lehrveranstaltung am Gymnasium (20 % der Note).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Vermittelt werden Grundlagen der Kommunikation und Didaktik, Kommunikationsmethodik, Kommunikationsregeln und deren Anwendung im Berufsalltag sowie zielorientierte Gesprächsführung. Außerdem werden Ausdruck und Sprache, Darstellung des Studienganges, Darstellung der Inhalte und deren praktische Vermittlung, die Organisation von Unterrichtseinheiten an den involvierten Schulen, die Charakterisierung des Unterrichtsbedarfs und Belange der Öffentlichkeitsarbeit behandelt.

Intended Learning Outcomes:
Nach der Teilnahme am Modul können die Studierenden grundlegende Beratungs- und Kommunikationsmodelle analysieren und die dahinterliegende Theorie den Modellen entsprechend zuordnen.

Des Weiteren können die Studierenden anhand von Fallbeispielen Beratungs- und Kommunikationsmodelle anwenden.
Darüberhinaus überprüfen sie ihre eigene Grundhaltung und reflektieren ihr eigenes Beratungs- und Kommunikationsverhalten. Die Studierenden können Lernziele passend zur jeweiligen Zielgruppe und zu den jeweils zu vermittelnden Inhalten formulieren und definieren.
Sie können entlang der Lernziele eine Unterrichtseinheit zeitlich in eine sinnvolle Reihenfolge bringen und können entsprechende Unterrichtsmethoden passend zu den Zielen auswählen.
Sie können einen Lehrplan für Ihre Unterrichtseinheit gestalten und auch umsetzen. Des weitern können die Studierenden ihre inhaltlichen Themen verbindlich erläutern und sie in Verbindung setzen mit den Arbeitsfeldern des Wissenschaftszentrums.Sie können den inhaltlichen Bedarf der Schule analysieren und den Unterrichtsumfang planen und sie sind befähigt Presse- und Öffentlichkeitsarbeit mit Inhalten und Intention aus dem Bereich Nachwachsender Rohstoffe zu koordinieren.

Teaching and Learning Methods:
Neben der Vorlesung werden Übungen, Rollenspiele, Fallstudien und Exkursionen und in Videoanalysen werden Einzel- und Gruppenpräsentationen durchgeführt und ananlysiert. Außerdem findet eine Lehrprobe vor einer Schulklasse eines Gymnasiums der Region statt.

Media:
Präsentationen, Skriptum, Video, Übungsblätter, Flipchart,
Powerpoint, Filme zeigen, Anschauungsobjekte (nachwachsende Rohstoffe), Fallbeschreibungen, Schultafel, Powerpoint

Reading List:
Schulz von Thun, F. (2019). Miteinander reden 1-4: Störungen und Klärungen. Stile, Werte und Persönlichkeitsentwicklung. Das "Innere Team" und situationsgerechte Kommunikation. Fragen und Antworten. Hamburg: Rowohlt Verlag.

Lippitt, G. & Lippitt, R. (2015). Beratung als Prozess: Was Berater und ihre Kunden wissen sollten. Leonberg: Rosenberger Fachverlag.

Weisbach, C.-R., Sonne-Neubacher, P. & Praetorius, I. (2015). Professionelle Gesprächsführung: Ein praxisnahes Lese- und Übungsbuch. München: Deutscher Taschenbuch Verlag.

Berger, F. (2012). Personenzentrierte Beratung. In J. Eckert, E.-M. Biermann-Ratjen & D. Höger (Hrsg.). Gesprächspsychotherapie. Lehrbuch für die Praxis (S. 279-309). Berlin: Springer."

Responsible for Module:
Claudia Martin

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

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

Module Description

CS0259: Communication and Presentation | Kommunikation und Präsentation

Version of module description: Gültig ab winterterm 2022/23

Module Level: Bachelor	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 the course of the semester elaboration of presentations (individual and group presentations, role play, case processing in the group, video analyses) shall be expected (non-graded) as an exam achievement by the students. The module shall be terminated by a written test (90 min). In this exam the students shall convey different models from communications psychology without tools or illustrate them by using different mentioned scenarios.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The module of Communication and Presentation is divided into the following fields:

• Basics of communications and communication methodology
• Communication rules nd their application in daily professional life
• Axioms of communications
• The four levels of communications ('four-ear-model')
• Communications in groups
• Giving and taking constructive feedback
• Do´s and Don´ts of communications
• Advantageous basic attitudes and communication techniques of non-directive conversation guidance

Intended Learning Outcomes:
After having participated in the module the students are able to understand basic communication models and allocate underlying theory to models accordingly.
Furthermore the students are able to describe communication by using case studies.
The four-level model of communications may be used in everyday life and in professional life.
When communicating in groups the students may give and take constructive feedback.

Teaching and Learning Methods:
During the lecture a speech (including discussion) will be worked out by the students. During the exercises role plays, case studies will be performed. In video analyses individual and group presentations shall be performed and analysed.

Media:
Presentations, script, video, exercise sheets, flipchart, powerpoint, showing films

Reading List:
Schulz von Thun, F. (2014). Miteinander reden 1: Störungen und Klärungen. Allgemeine Psychologie der Kommunikation. Hamburg: Rowohlt Verlag.
Schulz von Thun, F. (2014). Miteinander reden 2: Stile, Werte und Persönlichkeitsentwicklung. Differentielle Psychologie der Kommunikation. Hamburg: Rowohlt Verlag.
Schulz von Thun, F. (2014). Miteinander reden 3: Das "Innere Team" und situationsgerechte Kommunikation. Hamburg: Rowohlt Verlag.
Schulz von Thun, F. (2014). Miteinander reden 4: Fragen und Antworten. Hamburg: Rowohlt Verlag.

Responsible for Module:
Claudia Martin (martin.cm@t-online.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

CS0260: Energy and Economics | Energy and Economics [EUW]

Version of module description: Gültig ab summerterm 2022

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:
The examination will take the form of a written test (60 minutes). The students prove that they can understand and answer questions and the connections between the energy conversion, the conversion of renewable raw materials, the energy supply in general and the current energy-political and economic situation. Group work can be included and be part of the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prior participation and passing of the fundamentals of Thermodynamics module is required for participation in the Energy and Economics module.

Content:
The module deals with the basics of energy sources, climate change and the technology of the heat, electricity and fuel market and the use of renewable raw materials, including an introduction to simple technical systems and current topics on the energy industry. It also deals with electricity trading, CO2 trading and the current situation of various energy technologies.
In exercises small examples are calculated to the economy (production costs of heat and power of plants (e.g. combined heat and power plants).

Intended Learning Outcomes:
By participating in the module, students will be able to understand the energy sources and simple principles of energy conversion into heat and electricity. They can perform simple economic assessments of energy systems and understand related market mechanisms of the electricity and heat market.

Teaching and Learning Methods:
The module consists of a lecture with exercises. The contents of the lecture are conveyed in the lecture and through presentations.

Media:
Presentations, exercise

Reading List:
Kaltschmitt, M.; Hartmann, H.; Hofbauer, H.: Energie aus Biomasse, 2. Auflage, Springer, ISBN 978-3-540-85094-6, 2009
Karl, J.: Dezentrale Energiesysteme, Oldenbourg, ISBN 3-486-27505-4, 2004/

Responsible for Module:
Gaderer, Matthias; Prof. Dr.-Ing.

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

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

Module Description

CS0261: Phytopharmaceuticals and Natural Products | Phytopharmaceuticals and Natural Products [Phytopharm]

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
Knowledge of the covered topics of phytopharmaceuticals and natural products compounds is assessed in a written examination (90 minutes). In addition, students are required to explain the medicinal effects of medicinal plants in the examination using examples.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Organic and anorganic chemistry, botany

Content:
Content of the lecture:
-definition of medicinal plants and phytopharmaceuticals
-position of phytopharmaceuticals in pharmacology
-compounding (tea drugs, soluble extracts, sCO_2 extracts, steam destillation, pure substances)
-effect-determining components and frequent mechanisms (inflammation cascade, infections, coagulation system, neurotransmission, digestive system)
-typical medicinal plants grown in Europe
-international trade in medicinal plants
-important classes of compounds (terpenes, steroids, coumarine, alcaloids, vitamins, saccharides)
-quality determination and typical methods (chromatography)
-falsification and chemotype (chemical race)
-drug regulator affairs (authorisation, documents)
-use of medicinal plants in practice

Intended Learning Outcomes:
After their participation, students can explain the production of phytopharmaceuticals derived from typical medicinal plants (from collection to quality control). They can relate chemical compounds and medical effects of typical examples.

Teaching and Learning Methods:
The lecture takes the form of oral presentation given by teaching staff with the help of PowerPoint media, books and other written material.

Media:
PowerPoint presentation and printed handout. Laboratory equipment for experiments.

Reading List:
Deutschmann, F., Hohmann, B., Sprecher, E., Stahl, E., Pharmazeutische Biologie, 3 Bde., G. Fischer Verlag, 1992

Responsible for Module:
Riepl, Herbert; 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

CS0262: Literature Seminar: Redox Enzymes in Electrobiotechnology | Literature Seminar: Redox Enzymes in Electrobiotechnology [Literature Seminar: EBT]

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The competence to conduct a literature search with digital methods, analysis of the state of the art and frame a subject specific question is to be demonstrated in the form of a presentation. For this purpose, groups of two are formed, whereby each of these groups is given a branch in the field of bioelectrochemistry. With the help of current literature, they should evaluate the state of the art and how to further develop this field by designing a novel research project. The results are presented and defended in a 20-minute oral presentation at the end of the term.

Repeat Examination:

(Recommended) Prerequisites:
Successful participation in the module "Einführung in die Elektrochemie" or “Advanced Electrochemistry” or consolidated knowledge in the field of electrochemistry and successful participation in the module “Enzyme und ihre Reaktionen” or “Enzymatic Biotransformations”.

Content:
This course focuses on the field of enzymes useful in electrobiotechnology and biophotoelectrochemistry. In particular, the structured analysis of publications found and an efficient evaluation according to their usefulness for one's own research question will be discusses. Additionally, the course will cover,
- detailed and critical examination of published results and the pitfalls of common measurement techniques.
- the submission and reviewing processes including templates/platforms for authors and for reviewers.

- review and presentation of various recent scientific discoveries in the field of bio(photo)electrochemistry.
- examples of current research projects including research proposals.
- development of novel projects and how to find a good working hypothesis.
- the process of turning the working hypothesis into a research proposal.

Intended Learning Outcomes:
After successful participation in this module, students will be able to:
- understand and analyse the structure of a scientific publication in the topic of redox enzymes in electrobiotechnology and biophotoelectrochemistry.
- critically assess the issues in the conculsion due to the methods used to investigate a given system.
- classify the literature found according to its quality and its usefulness for their own research question.
- evaluate the state of the art of redox enzymes used in electrobiotechnological and biophotoelectrochemical applications.
- based on the literature develop a research project with a novel working hypothesis.

Teaching and Learning Methods:
In this seminar, the students are supposed to analyse and evaluate given publications in the first weeks. In the seminar the findings are debated with a special focus on the issues and pitfalls due to the used measurement methods. The objective is to teach how the same measurement results can lead to different conclusions especially if not all features of a measurement method are considered. Supplementary presentations about submission processes and research proposals should teach how to develop and secure funding for a new research project.

Media:
Presentations, case studies, discussion rounds, Moodle course with discussion forum.

Reading List:

Responsible for Module:
Prof. Dr. Nicolas Plumeré Dr. Martin Winkler Dr. Vincent Friebe

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

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

Module Description

CS0263: Geothermal Energy Systems | Geothermal Energy Systems [GeoE]

Potentials of geothermal energy supply

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:
Students demonstrate their knowledge and understanding of geothermal systems and their potential for energy supply in form of a written examination (90 minutes). Students deliver definitions, describe and outline relevant processes for the geothermal energy supply. Furthermore, students calculate different technical specifications and parameters based on provided practice-oriented examples.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful completion of the module "Basics in engineering" and "Introduction to Energy conversion and Energy economy". Knowledge and interest in Geology and Physics are valuable.

Content:
The course focuses on the variety of options for geothermal energy supply. This includes an introduction to relevant geological expert knowledge such as formation of the earth, earth's structure, geothermal heat sources, the rock-cycle as well as mechanism of subsurface heat transport. After an introduction to deep geothermal exploration (drilling, drilling technology and related risks) the focus of the course is placed on shallow geothermal energy and use of ground-coupled heat pump systems.

This includes the design and working principle of a heat pump system and its integration in technical building equipment as well as the analysis of their ecological and economic sustainable operation on living quarter scale. The analysis is also done with regards to existing technical guidelines as well as legal boundary conditions. Practice-oriented tasks will be used to demonstrate and critically evaluate the basic planning steps of heat pump systems and obtaining the relevant parameters. Existing and innovative geothermal exploration concepts will be analyzed and discussed against this background.

Intended Learning Outcomes:
After successful completion of the module, students acquire in-depth understanding of geothermal energy systems including relevant geological and hydrogeological processes. Students can evaluate the ecological as well as economic sustainability of geothermal heat source systems. They can test plausibility of dimensioning ground-coupled heat pump systems and understand, explain and comprehend heat transport processes and regeneration processes within the subsurface.

Students prepare short, practice-oriented tasks as homework in a project team (group work). Thereby, they acquire the ability to view and assess information within a limited period of time and solve practice-oriented questions. The edited information and results are passed on to the other participants accordingly with the focus on sharing results in the form of a written report as well as team work.

Teaching and Learning Methods:
The content is taught in lectures and presentations and strengthened by case studies and exercises. If applicable, the module is complemented by an excursion.

Media:
Lecture, Power Point presentation, blackboard, case examples, topics prepared and presented by participants.

Reading List:
Bayerisches Staatsministerium für Landesentwicklung und Umweltfragen (2005): Oberflächennahe Geothermie.
Bauer, M., Freeden, W., Jacobi, H., Neu, Th. (Hrsg.) (2018): Handbuch Oberflächennahe Geothermie. Springer Spektrum, 1. Auflage.
Stober, I. & Bucher, K. (2014): Geothermal Energy. Springer Spektrum, 1st edition.
Hölting, B., Coldewey, W.G. (2013): Hydrogeologie. Springer Spektrum, 8. überarbeitete Auflage.
Dassargues, A. (2018): Hydrogeology: Groundwater Science and Engineering, CRC Press, 1st edition.
Grotzinger, T. & Jordan, T. (2017): Press/Siever Allgemeine Geologie. Springer Spektrum, 7. Auflage
Grotzinger, T. & Jordan, T. (2014): Understanding Earth. W.H. Freeman & Company, 7th edition

Responsible for Module:
Vienken, Thomas; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Geothermal Energy Systems (Vorlesung mit integrierten Übungen, 4 SWS)

Vienken T [L], Vienken T
For further information in this module, please click campus.tum.de or here.

Module Description

CS0264: Polymer Processing | Polymer Processing [PolyProc]

Processing of polymers intro plastic parts

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
The content and learning objectives of the lecture are examined at the end of the semester in a written test (90 min). An oral pre-test containing safety relevant laboratory work issues must be carried out before the individual pratical course. A written report on the practical course consisting of approximately five pages must be submitted. The written report is an ungraded student achievement.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Polymer chemistry, polymer physics, rheology fluid mechanics, Biogenic Polymers

Content:
The lecture deals with unit operations, basic techniques and processes of plastic material processing, e.g. compounding, extrusion, injection molding, plastic part forming processes and also typical applications. In addition, methods for characterizing thermal and mechanical properties are presented. One focus here is the connection between the processing parameters and the end-use properties. The acquired knowledge is deepened in the accompanying practical course. Injection molding and extrusion tests are carried out and the test specimens are then characterized with regard to their thermal, optical and mechanical properties. Additional foci will be laid on the chemistry, structure and classification of polymers and plastic parts. The lecture also deals with the physical properties of polymers and plastic materials involving materials science. Characterization of the mechanical and thermal properties and their effects on processing, viscosity, viscoelastic behavio will be discussed

Intended Learning Outcomes:
In addition to the chemical-physical basics of polymeric materials, this module imparts the methodical knowledge about classic and modern innovative processing methods of polymeric materials. The students are able to sensibly classify plastic materials, their manufacture and use them for specific applications. The basics for the production technology of plastic materials are acquired. After successfully completing the module, students are able to select and use methods for processing plastic. They will be able to assess sustainability aspects of the polymer production process in terms energy consumption and materials use. Through practical work, the competence for the meaningful use of testing and characterization methods of polymer materials is acquired.

Teaching and Learning Methods:
Lecture (lecture by teaching staff with Power Point slide media, books and other written material), laboratory practical course (experimentation of the students under supervision)

Media:
Power Point slide presentations; Drawing and writing on a black board; Laboratory equipment for experimentation

Reading List:
Polymer Engineering; Technologien und Praxis; Peter Eyerer, Peter Elsner, Thomas Hirth
Polymer Extrusion; Chris Rauwendaal
Extrusion: The Definitive Processing Guide and Handbook; Harold F. Giles, Jr.
Einführung in die Kunsstoffverarbeitung; Michaeli, W.
Werkstoffkunde der Kunststoffe; Menges, G.

Responsible for Module:
Zollfrank, Cordt; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Polymer Processing (Practical) (Praktikum, 1 SWS)
Zollfrank C [L], Helberg J

Polymer Processing (Lecture) (Vorlesung, 2 SWS)
Zollfrank C [L], Helberg J
For further information in this module, please click campus.tum.de or here.

Module Description

CS0265: Biorefinery | Biorefinery [BioRaff]

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
Students answer questions in a written examination (60 minutes) that will be graded. They thereby show that they have understood, can explain and are able to assess the various steps and processes involved in biorefinery. In an additional voluntary coursework (Mid-term), which is not part of the written exam, students individually study selected topics in the field. Here, they apply their knowledge acquired in lectures to deduce and/or evaluate processing methods. Findings are presented in a "research paper" and a short presentation (5 min). Bonus points (up 10/60 depending on the quality) will be awarded for the coursework on the written exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in chemistry and biology; Module "Renewables Utilization"

Content:
Contents of the module include:
comparison of biorefinery and mineral oil refinery; role of biorefineries for the development of a sustainable biobased economy; presentation and analysis of different biorefinery systems (e.g. green biorefinery, lignocellulose biorefinery);
selected procedures for the extraction of resources (focused on lignocellulose);
selected biogenic compounds for further processing (e.g. saccharides, lipids/oils, lignin);
selected pathways of their use (e.g. bioalcohols, polylactic acid, proteins, succinate and other components);
cascade use of materials and energy.

Intended Learning Outcomes:
After completion of the course, students will have understood the concept of biorefinery, analogous to and in contrast with mineral oil refinery. Students are able to describe various biorefinery concepts and methods for processing renewable resources in biorefineries. The understand the importance of biorefineries for a future sustainable biobased economy. They are able to apply their knowledge to the analysis and assessment of viable biorefinery systems, taking into account their respective advantages and disadvantages. In addition, they have trained their competences in literature research and critical evaluation as well as in the preparation of "research papers".

Teaching and Learning Methods:
Lecture: talks given by teaching staff; Exercise: more detailed studies on selected topics; students individually prepare one topic and finally present their results ("research paper").

Media:
PowerPoint presentation, blackboard

Reading List:
B. Kamm, P. R. Gruber, M. Kamm (Hrsg.), Biorefineries - Industrial Processes and Products, Vol. 1-2, Wiley-VCH, Weinheim, Germany, 2006

Responsible for Module:
Schieder, Doris; Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Biorefinery (Seminar) (Seminar, 1 SWS)
Schieder D

Biorefinery (Lecture) (Vorlesung, 2 SWS)
Schieder D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0266: Sustainable Chemistry | Sustainable Chemistry

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
The examination will take the form of a written test (60 minutes). In this examination the competence for the evaluation of chemical processes and for the derivation of optimization strategies shall be proven. No aids are permitted in the written examination. In order to additionally check whether the students are able to communicate scientific topics in front of an audience and whether they are able to critically deal with problems in individual steps, the results of the processing of the case studies are presented in the form of a 20-minute presentation alone or in a group. This presentation is ungraded study achievement.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the module "Basics in chemistry" or comparable knowledge in chemistry.

Content:
The module teaches basic principles of sustainable chemistry. Focus is set on the evaluation of chemical processes in view of efficiency, atom economy and amount of waste. In addition, optimizsation strategies related to catalytical methods, raw material and energy efficiency are discussed. Students individually prepare current topics related to sustainable chemistry and present them in the seminar.

Intended Learning Outcomes:
By attending the module events, students are able to highlight the principles of sustainable chemistry. Students can analyze the efficiency and waste quantities of chemical reactions and evaluate various alternative processes. Furthermore, they are able to discuss further chemical aspects of the conversion of renewable raw materials into valuable products. Through the

independent development of case studies, the students master all the steps that are important in the critical examination of problems (consideration of the example, development of criteria for evaluation, assessment, presentation of the results to an audience).

Teaching and Learning Methods:
Lecture with board addresses and presentations: Basic development and derivation of technical contents; seminar with written tasks. Consolidation of the technical learning contents through learning activity of the students themselves, e.g. through independent development of case studies from the field of sustainable chemistry.

Media:
Presentation, script, examples

Reading List:
Stanley E. Manahan: Green Chemistry, ISBN: 0-9749522-4-9

Responsible for Module:
Zollfrank, Cordt; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Sustainable Chemistry (Seminar) (Seminar, 1 SWS)
Zollfrank C [L], Helberg J, Zollfrank C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0267: Biological Materials | Biological Materials

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor/Master	**Language:** English	**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:
Understanding of the course contents and their application will be tested in a written exam of 90 minutes duration. In detail, the students are required to describe the physical and chemical foundations of the formation, as well as relations between the hierarchical structure and properties, of typical biological materials. Further, the transfer of this knowledge to technological applications and to the design of novel biologically inspired materials, as covered in the course, is a test subject. Lecture notes are not permitted.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in geometry and chemistry

Content:
The module Biological Materials in Nature and Technology covers important biological functional materials, based on basic materials scientific knowledge. This encompasses such materials that fulfill, in their biological system, or in a technological application, either in native state, or modified, one or more specific functions. Differences and similarities to classical engineering materials are pointed out. In addition to the modules Bioinspired Materials and Instrumental Analysis, the students learn important methods for structural and property analysis. After a presentation of the classification of biological materials, students- are taught the basic correlations between hierarchical structuring and macroscopic properties. As the most important complex, the influence of hierarchical structuring on the mechanical properties of materials will be discussed. The students learn, which modes of failure can occur in biological systems and how they are influenced. In this context, modification routes for biological materials are shown and discussed.

Intended Learning Outcomes:
After successful completion of the module, the students are enabled to name criteria for a proper usage of biological materials. They can name specialized methods for the analysis of hierarchical structures and the derived material properties and explain the correlations between structure and external properties. Further, they are able to describe tailored modification routes for biological materials.

Teaching and Learning Methods:
Lecture with discussion and case studies

Media:
Presentation, slides

Reading List:
Structural Biological Materials: Design and Structure-Property Relationships. Eds Elices M, Pergamon-Elsevier Science Ltd, Oxford, (2000).
Fratzl P & Harrington MJ. Introduction to Biological Materials Science. Wiley VCH, Weinheim, Germany, (2015).

Responsible for Module:
Van Opdenbosch, Daniel; 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

CS0268: Applied Process Engineering | Applied Process Engineering [APE]

Applied process engineering

Version of module description: Gültig ab summerterm 2023

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 examination is performed in the form of a written examination (60 minutes). The students prove that they can solve arithmetic problems and apply methods of cost estimation and economic feasibility studies of process engineering processes as well as answer questions about optimization and cost reduction in writing.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Apparatus and plant construction, bioprocess engineering, chemical reaction technology, thermal process engineering

Content:
The module teaches the basics that are necessary for estimating costs and assessing the profitability and sustainability of a production process. Various methods of cost estimation are taught, as well as their suitability and accuracy in different project phases. The contents are in particular the following:

- Project/design phases (proof of principle, process development in the laboratory, piloting, demonstration, concept study, basic engineering, detail engineering, construction, commissioning, production, debottlenecking)
- Cost estimation (methods, including the Monte Carlo method, accuracy, process variants, sensitivity analyses, tornado plots)
- Assessment of Sustainability

- Investment versus CMO production
- Site selection and plant size
- permits
- Time plans
- Selected examples from industry
- (Operational) optimization and Lean Six Sigma tools
- Business Case Evaluation (Payback, Discounted Cash Flow, Net Present Value, Sales at Maturity)

Intended Learning Outcomes:
After participating in the module, the students are able to estimate operating and investment costs in the respective design phases for a production plant and to reduce production costs during the operation of a plant.

Teaching and Learning Methods:
In the lecture, the essential basics are presented and worked out. The content learned is applied to concrete practical questions in the exercise. Special software for cost estimation is learned in a computer exercise and sample calculations are carried out. Individual topics are worked on and presented in groups. After participating in the module, the students are able to apply the basics of cost estimation and to evaluate the profitability and sustainability in different project phases.

Media:
Presentations, interactive quizzes, case descriptions, computer exercises with software

Reading List:
Peters, M. S., Timmerhaus, K. D., West, R. E., 2003. Plant Design and Economics for Chemical Engineers. McGraw-Hill Education. ISBN 9780072392661

Vasudevan, P. T., Ulrich, G. D., 2004. Chemical Engineering Process Design and Economics: A Practical Guide. United States: Process Pub.. ISBN 9780970876829

Penney, W. R., Couper, J. R., Fair, PhD, J. R., 2012. Chemical Process Equipment: Selection and Design. Netherlands: Elsevier Science. ISBN 9780123969590

Towler, G., Sinnott R., 2021. Chemical Engineering Design - Principles, Practice and Economics of Plant and Process Design. Elsevier. ISBN 9780128211793

Chmiel, H. Bioprozesstechnik. (2011). Germany: Spektrum Akademischer Verlag. ISBN 9783827424761

Responsible for Module:
Zavrel, Michael; Prof. Dr.-Ing.

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

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

Module Description

CS0269: Accredited Module 15 ECTS | Anerkanntes Modul 15 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 15	**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

CS0269-2: Accredited Module 15 ECTS | Anerkanntes Modul 15 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	Language:	Duration:	Frequency:
Credits:* 15	**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

CS0270: Accredited Module 7 ECTS | Anerkanntes Modul 7 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	Language:	Duration:	Frequency:
Credits:* 7	**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

CS0270-2: Accredited Module 7 ECTS | Anerkanntes Modul 7 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	Language:	Duration:	Frequency:
Credits:* 7	**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

CS0270-3: Accredited Module 7 ECTS | Anerkanntes Modul 7 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	Language:	Duration:	Frequency:
Credits:* 7	**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

CS0271: Accredited Module 12 ECTS | Anerkanntes Modul 12 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 12	**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

CS0271-2: Accredited Module 12 ECTS | Anerkanntes Modul 12 ECTS

Version of module description: Gültig ab summerterm 2022

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 12	**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

CS0272: Experimental Lab - Architecture, Science & Design | Experimental Lab - Architektur, Wissenschaft & Design

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor	**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:
Im Laufe des Semesters wird von den Studierenden die Ausarbeitung praxisorientierter Übungen sowie eine Studentische Projektarbeit erwartet. Mit den Übungen soll das Verständnis für Gestaltung und Design im Kontext zu wissenschaftlichen Themen dargelegt und erläutert werden. Bei der Projektarbeit erarbeiten die Studierenden in kleinen Teams eigene Ideen im öffentlichen Stadtraum. Als Prüfungsgesamtleistung werden die Übungen als Einzelarbeit und eine abschließende Präsentation der Projektarbeit in Teamarbeit bewertet. Die Idee, Funktion, Kontext, kreative Ausarbeitung der Konzepte und die Art der Präsentation gehen in die Bewertung mit ein.

Prüfungsart: mündlich (Präsentation); Prüfungsdauer: 30 Minuten

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Der Inhalt dieses Moduls ist in drei Schwerpunkte gegliedert: Der erste Schwerpunkt ist eine Einführung und ein gemeinsamer „Mind Opening“ Workshop im Spannungsfeld von Wissenschaft, Design und Architektur. Zudem werden den Studierenden Grundlagen Visueller Kommunikation vermittelt, die ihnen künftig bei der Umsetzung eigener Präsentationen dienen sollen. Es ist ein Gastvortrag über „Interdisziplinäre Zukunftsthemen“ geplant.

Ein weiterer Schwerpunkt umfasst die Vermittlung grundlegender Kenntnisse im Bereich Kunst, Design und Architektur an die Studierenden. Dies geschieht in Form von Vorträgen sowie praktischen, experimentellen Übungen mit verschiedensten Materialien natürlichen Ursprungs

(Nachwachsenden Rohstoffen). Dabei wird auf deren komplexe Wahrnehmung im privaten als auch öffentlichen Raum eingegangen und die große Bandbreite möglicher Anwendungen thematisiert. Es soll die Kreativität der Studierenden angeregt werden, Wissenschaft & Forschung in den Kontext weiterer Themenbereiche zu stellen. Dieser Synergieeffekt soll innovative Denkansätze anstoßen und neue Spannungs- und Forschungsfelder eröffnen.

Der dritte Schwerpunkt ist die Umsetzung der erlernten Methoden und Ansätze in einem eigenen studentischen Projekt im öffentlichen Raum, in dem die vielfältigen Nutzungsmöglichkeiten von Nachwachsenden Rohstoffen erfahrbar gemacht werden sollen. Die Kommunikation über die gewonnenen Erfahrungen und Ergebnisse innerhalb des Kurses sowie gegenüber der Öffentlichkeit sind weiterer, zentraler Bestandteil des Moduls. Es sollen die Präsentationsfähigkeiten der Studierenden für die Umsetzung ihrer eigenen Ideen gefördert werden.

Intended Learning Outcomes:
Nach der Teilnahme an dem Modul sind die Studierenden in der Lage, Grundlagen und Methoden von Gestaltung und Design zu verstehen und diese auf Produkte aus Nachwachsenden Rohstoffen anzuwenden. Dabei können die Studierenden die speziellen Anforderungen und Notwendigkeiten, die sich aus der Verwendung natürlicher Materialien ergeben, ermitteln und in Lösungen umsetzen. Die in den Übungen und aus der Projektarbeit gewonnenen Erfahrungen erlauben es den Studierenden, kreative Lösungen mit Nachwachsenden Rohstoffen zu erfassen und diese zu demonstrieren. Mit den erworbenen Kenntnissen aus der Projektarbeit können sie mit verschiedenen Techniken, die sie aus der eigenen Kreativität transferieren, Präsentationen ansprechend planen und selbständig vortragen.

Teaching and Learning Methods:
In kleinen Teams realisieren und präsentieren die Studierenden Übungen und eine Projektarbeit zu einem bestimmten Thema. Die Ergebnisse werden innerhalb des Kurses und/oder im öffentlichen Raum vorgestellt.
Weitere Methoden sind Vorträge zu den Themen Kunst, Design & Architektur; themenbezogene, experimentelle Übungen; ein Gastvortrag; eine Exkursion und/oder Ausstellung; Projektarbeit in Teams mit konstruktivem, gegenseitigem Austausch und abschließender Präsentation

Media:
Nutzung aller verfügbaren multimedialen Möglichkeiten

Terminplan, Präsentationsfolien, Übungsaufgaben werden den Studierenden digital zu Beginn des Semesters zur Verfügung gestellt.

Reading List:
Die aktuellsten Literaturempfehlungen werden den Studierenden zu Beginn des Semesters bei der Einführung in das Modul zur Verfügung gestellt.

Responsible for Module:
Verena Stierstorfer

Courses (Type of course, Weekly hours per semester), Instructor:
Spannungsfeld Architektur, Wissenschaft & Design (Vorlesung, 1 SWS)
Stierstorfer V [L], Stierstorfer V

Spannungsfeld Architektur, Wissenschaft & Design; begleitende Übungen (Vorlesung mit integrierten Übungen, 1 SWS)
Stierstorfer V [L], Stierstorfer V

Experimental Lab - Projektarbeit (Projekt, 2 SWS)
Stierstorfer V [L], Stierstorfer V
For further information in this module, please click campus.tum.de or here.

Module Description

CS0273: Electrochemical Modelling | Electrochemical Modelling [ECM]

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 learning results are demonstrated in form of a project. The students pick a topic of their interest in electrochemical modelling from a prepared selection. The students present this topic to their peers in the form of an 20 minute long oral presentation (+10 min discussion). In explaining their chosen topic, the students should utilize one or more of the methods learned in this course. After four weeks the student's work is present and evaluated. The student is graded based on his/her progress and approach presented in the oral summary.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
The student should know general chemistry, physics, and mathematics. Furthermore, a good knowledge of physical chemistry and electrochemistry is necessary. A basic knowledge of computer programming i.e., MATLAB is preferable.

Content:
- Physical models: continuum approximation, conservation laws, constitutive relationships, boundary conditions and the current distribution, microscopic models of electrode kinetics.
- Formulation and approximation: scaling and dimensional analysis, dimensionless groups.
- Steady-state systems: modelling voltammetry under steady reaction-diffusion, methods for solving linear systems, approximate/asymptotic methods for non-linear reaction kinetics.
- Transient systems: modelling transient potential step chronoamperometry and cyclic voltammetry with and without reactions.
- Numerical methods: approximations for first and second derivatives, explicit and implicit methods.

Intended Learning Outcomes:
The students understand the basic concepts of modelling electrochemical systems, focusing on a breadth of analytical and numerical methods applicable to solving a wide range of different systems. Furthermore, they are able to identify key processes and boundary conditions and translate these into mathematical expressions. Thus, they can systematically implement simplifications to model complex electrochemical phenomena. Importantly, they can formulate a problem and find an approximate solution using scaling, dimensionless groups, and dimensionality reduction. In particular, they can analyse and distinguish between various electrochemical methods and know how to model these. Overall, they succeed in planning and constructing their own mathematical models, which they can solve either analytically or numerically to find the current response, while reviewing and evaluating their assumptions for deriving the governing mathematical equations.

Teaching and Learning Methods:
The teaching content is presented with lectures, text documents, PowerPoint presentations, and blackboard sketches. This enables a way of delivering the teaching content to the students in detail and answering questions as soon as they arise. PowerPoint slides and blackboard sketches add visual assistance to understand the complex relationships in electrochemistry and how to express these relationships in terms of mathematical equations. Additionally, the students are provided with exercises to consolidate what they have learned in the lecture with hands-on modelling examples and reviewing the mathematical tools necessary to solve the equations. The exercises and solution are discussed and explained in the practical lessons.

Media:
Presentations, PDF-script, case studies and algorithms for models in MATLAB.

Reading List:
R. G Compton, E.Laborda, K. R. Ward, Understanding Voltammetry: Simulation of Electrode Processes.
J. M. Savéant, C. Costentin, Elements of Molecular and Biomolecular Electrochemistry.
A. J. Bard, L. R. Faulkner Electrochemical Methods: Fundamentals and ApplicationsElectrochemical Methods: Fundamentals and Applications.

Responsible for Module:
Plumeré, Nicolas; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Electrochemical Modelling (Vorlesung, 2 SWS)
Johnson III B [L], Höfer T, Johnson III B

Electrochemical Modelling (Übung, 2 SWS)
Johnson III B [L], Johnson III B
For further information in this module, please click campus.tum.de or here.

Module Description

CS0274: Economic History and Comparative Development | Economic History and Comparative Development

The roots of wealth and inequality across the globe

Version of module description: Gültig ab winterterm 2022/23

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:
Achievement of desired learning objectives shall be verified in a term paper (max. 10 pages) and an oral presentation in a group. The students will provide an overview of their chosen topic and present the findings in the context of the relevant literature in a group presentation (each student has to present 10 minutes). The oral presentation shall be assessed according to content and rhetoric aspects. The term paper is written individually and summarizes the relevant literature, empirical method, data, and key findings. Weighting: Term paper 2, Presentation 1.

Repeat Examination:

(Recommended) Prerequisites:
Advanced Development Economics

Content:
Why, when and how did the world become rich/poor? Research of contemporary economic development has often neglected historical factors in explaining differences in inequality and wealth. The study of the past was usually delegated to the field of economic history, and connections between historical factors and present-day economic outcomes were seldom made. This course will cover the rapidly growing body of research within economics that takes a historical perspective into account.

The course uses a historical and comparative approach to understand the evolution and development of societies. In particular, we will examine research that asks whether differences in economic development, wealth and inequality today have historical roots. In addition, we will study different mechanisms and channels through which history matters. Particular attention will be paid to the role of institutions, geography and culture in explaining historical persistence. The course also covers important empirical methods to identify the causal effects of past historical events (e.g., the different types of colonial institutions) on current outcomes (e.g., GDP per capita in 2010).

While the material covered in the course is grounded in the field of economic history, there is a natural overlap with other fields in economics, particularly development economics, political economy, and cultural economics, as well as overlap with other disciplines, such as history, psychology, political science, anthropology, archaeology, and geography.

Intended Learning Outcomes:
After attending the module, students will understand what historical factors influenced economic development and how persistent these factors are, i.e., how they still affect economic outcomes across countries today. Students can apply theories, concepts, and analytical techniques associated with economic history and microeconomics. Students will be also capable of using empirical methods to analyze persistent effects of historical data. In addition, students will learn to present scientific results and write a term paper according to scientific standards.

Teaching and Learning Methods:
The lecture will be mostly done by presentations (PowerPoint). In addition, articles from newspapers and journals are integrated into the lectures. Together with the lecturer, students will study the content and methods of the academic papers. In the exercises, the students themselves choose a topic related to economic history and comparative development. The findings of their analysis will be presented and discussed individually and / or in groups from different perspectives by the students. Students will reproduce what has been learned in a written work (term paper).

Media:
Presentations, articles

Reading List:
- Oded Galor (2022), The Journey of Humanity. Random House.
- Joseph Henrich (2020), The Weirdest People in the World. Penguin Random House.
- Alberto Bisin and Giovanni Federico (2021), The Handbook of Historical Economics, Academic Press
- Bibliography of scientific publications

Responsible for Module:
Pondorfer, Andreas; Prof. Dr.sc.pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Economic History and Comparative Development (Vorlesung mit integrierten Übungen, 4 SWS)
Pondorfer A [L], Pondorfer A, Ahmed M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0275: Economic Valuation of Consumer and Environmental (non-market) Goods | Economic Valuation of Consumer and Environmental (non-market) Goods

Version of module description: Gültig ab summerterm 2024

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 will be given in the form of a written examination as well as students' presentations.
The students should be able to evaluate and use the taught methods of market analysis. Using case studies, students must discuss various questions related to the theoretical background of non market goods and consumer goods. Besides that, the students have to answer questions about the used statistical programs and data analysis. Duration of written examination: 60 minutes. The proportion of the written examination is 50% of the total grade.

The students' presentations aims to present the scientific methods and results of a student project elaborated during the semester. The students present individually or in groups the elaborated results and discuss them with their colleagues and lecturers. Powerpoint and presentation equipment are allowed for the presentations. Students must give an intermediate presentation (duration: 10 minutes) and a final presentation (duration: 20 minutes). Students will only be admitted to the final presentation if they have successfully completed the interim presentation. The proportion of the presentations is 50% of the total grade.

Both parts of the grade (written examination and presentation) must be passed in order to successfully complete the module.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites for the successful participation is knowledge about,
- basic knowledge about non-market goods

- basics of multivariate analysis methods
-basics in empirical data collection

Content:
This course aims to explain the valuation of consumer goods and non-market goods.

In the first part of the lecture, students will learn basic aspects of consumer goods and of environmental goods.
Consumer goods: The students get to know different types of consumer goods (e.g. durable goods, nondurable goods, services) and how they can be characterized.
Non-market goods: These goods provide many services, like clean air, carbon capturing or protection against floods or erosion. These ecosystem services are not traded on a market and accordingly do not have an observable market price. To show the value of environmental services, e.g. to evaluate policy measures that enhance or reduce ecosystem services, we need approaches for nevertheless quantifying the value of environmental services.

Based on the first part, the second part of the course introduces and discusses different methods for (non-) market valuation of consumer goods and environmental services. Students will learn the theoretical background of a Choice Based Conjoint Analysis as well as its application by means of examples. The analysis of sample data will also be discussed and practiced with the help of appropriate software (e.g. Sawthooth).

In the third part of the module, students have to apply the methods and tools they have learned. The students receive already collected data (in the field of consumer goods) or implement their own online survey using a Choice Based Conjoint approach (in the field of non-market goods). Students have to develop specific research questions based on the given data or non-market good scenario using also information provided in scientific literature. After that, students must analyze data using a Choice-Based Conjoint analysis to answer their research questions. In a final step, students must present their findings.

Intended Learning Outcomes:
After attending the module, students can characterize current topics and methods in the evaluation of consumer and environmental (non-market) goods. Students will learn to analyze and use different concepts for valuing consumer goods and environmental services as well as the concepts' strengths and weaknesses. Further, they will learn how to collect, analyze, and evaluate data by using choice analytics survey software as well as to interpret the results.

Teaching and Learning Methods:
The lecture will be mostly done by presentations. In addition, articles from newspapers and journals are integrated into the lectures. Together with the lecturer, students will study the content and methods of the academic papers.
In the project work, the students themselves either analyze collected data (which will be provided to the students) or implement an online survey for non-market goods and analyze the data

collected in this survey. The results of the evaluation are then presented and discussed individually and / or in groups from different perspectives by the students.

Media:
Presentations, slide scripts, articles

Reading List:
- Sawthooth manuels
- Hair, J.F., Black, W.D., Babin, B.J., & Anderson, R.E. (2013): Multivariate Data Analysis, Pearson, Upper Saddle River
- Champ, P.A., Boyle, K. J., and & Brown T. C., (2017): A Primer on Nonmarket Valuation, Springer

Responsible for Module:
Thomas Decker (thomas.anton.decker@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Economic Valuation of Consumer and Environmental (non-market) Goods (Vorlesung mit integrierten Übungen, 4 SWS)
Pondorfer A [L], Pondorfer A, Decker T
For further information in this module, please click campus.tum.de or here.

Module Description

CS0277: Sustainability and Risk Management | Sustainability and Risk Management

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/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:
Achievement of desired learning objectives shall be verified in a term paper (max. 15 pages) and an oral presentation in a group. The students will provide an overview of their chosen topic and present the findings in the context of the relevant literature in a group presentation (each student has to present 10 minutes). The oral presentation shall be assessed according to content and rhetoric aspects. The term paper is written individually and summarizes the relevant literature, empirical method, data, and key findings. Weighting: Term paper 2, Presentation 1.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
In the light of recent studies on climate change, economies face major challenges in achieving climate targets and halting global warming. Nowadays climate risks are a central challenge for the real and financial sector, which is why all companies and financial intermediaries must take climate risks into account in their risk management. The European Union sees the reorientation of the financial industry towards sustainable finance as a central bridge to the implementation of the Paris climate targets. In view of these challenges and in order to mitigate ESG (Environment, Social and Governance) risks, including climate risks, this course will examine the way in which business and society make an assessment of, control and transfer risks.
This course will provide an understanding and application of quantitative and qualitative methods of analyzing and managing risk within organizations. In addition, we will study different multiple risk management tools to make high quality decisions for balancing corporate risk and reward tradeoffs.

Financial risk topics will include the examination of derivative application uses for hedging risk, measuring Value at Risk and exploring external impacts such as market, credit and systemic risks.
Enterprise risk topics will include constructing frameworks for managing strategic, operational and outsourcing of business risks. We will examine ways to assess and measure risk along with organizing corporate governance policies.

Intended Learning Outcomes:
After attending the module, students will be prepared to function in a business environment, developing an awareness of the challenges, the tools, and the process of designing and implementing a sustainability and risk management program. Students can apply theories, concepts, and analytical techniques associated with sustainability and risk management. Students will be also capable of using empirical methods to analyze and evaluate risks. Moreover, students will develop the ability to identify strengths and weaknesses of approaches to solutions from fact-based analysis and to synthesise them creatively into improved solutions. In addition, students will learn to present scientific results and write a term paper according to scientific standards.

Teaching and Learning Methods:
The lecture will be mostly done by presentations (PowerPoint). In addition, articles from newspapers and journals are integrated into the lectures. Together with the lecturer, students will study the content and methods of the academic papers. In the exercises, the students themselves choose a topic related to sustainability and risk management. The findings of their analysis will be presented and discussed individually and / or in groups from different perspectives by the students. Students will reproduce what has been learned in a written work (term paper).

Media:

Reading List:
• Gardoni (Ed.) (2017). Risk and Reliability Analysis: Theory and Applications. Springer International Publishing.
• Tamas Vasvari (2015). Risk, Risk perception, risk management – a Rewiew of the Literature. Pablic finance Quarterly. State Audit Office of Hungary, vol. 60(1).
• A Risk Practitioners Guide to ISO 31000: 2018. (2018). Review of the 2018 version of the ISO 31000 risk management guidelines and commentary on the use of this standard by risk professionals. Institute of Risk Management. A company limited by guarantee. Registered in England number 2009507
• Borghesi A., Gaudenzi, B. (2013). Risk Management, Perspectives in Business Culture, Springer-Verlag Italia
• Peter Moles (2016). Management Sources of Financial Risk and Risk Assessment. Edinburgh Business School Heriot-Watt University Edinburgh
• Bessis,J. (2015) Risk Management in Banking 4th ed. (UK)
• Crouhy M, D Galai and R Mark (2009) Risk Management, New York: McGraw Hill.

• Greuning,H., Bratanovic, S. (2013) Analysing Banking Risks: A Framework for Assessing Corporate Governance and Risk Management, 4th ed. The World Bank
• Mechler, R. et al (eds.) (2019) Loss and Damage from Climate Change : Concepts, Methods and Policy Options, Cham
• Shin, Hyun Song (2019) Risk and Liquidity, Claredon Lectures in Finance
• Selected publications from Basel Committee on Banking Supervision, ESAs, EPCC, WMO.
• Aagaard A. (2019) Sustainable Business Models: Innovation, Implementation and Success. Palgrave Macmillan.
• Leleux, B. & van der Kaaij, J. (2019) Winning sustainability Strategies (Finding Purpose, Driving Innovation and Executing Change). Palgrave Macmillan
• Schoenmaker, D., & Schramade, W. (2019). Principles of Sustainable Finance. New York: Oxford University Press.
• Bielenberg, A., Kerlin, M., Oppenheim, J., & Roberts, M. (2016). Financing change: How to mobilize private sector financing for sustainable infrastructure. Chicago: McKinsey Center for Business and Environment.
• European Political Strategy Centre. (2017). Financing Sustainability, Triggering Investments for the Clean Economy. Brussels: European Commission.
• High-Level Expert Group on Sustainable Finance. (2018). Financing a Sustainable European Economy-Final Report. Brussels: European Commission.
• Filippi M.E. (2022). A role for municipal governments in leveraging transformative change for urban disaster risk management: The experience of Santa Fe, Argentina, with urban flood risk,Climate Risk Management, Volume 35.
• Bo Chen, Liuxin Chu (2022). Decoupling the double jeopardy of climate risk and fiscal risk: A perspective of infrastructure investment, Climate Risk Management, Volume 37
• Henry Ngenyam Bang, Nicholas Church Burton (2021). Contemporary flood risk perceptions in England: Implications for flood risk management foresight, Climate Risk Management, Volume 32

Responsible for Module:
Pondorfer, Andreas; Prof. Dr.sc.pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Sustainability and Risk Management (Vorlesung mit integrierten Übungen, 4 SWS)
Pondorfer A [L], Shkola V
For further information in this module, please click campus.tum.de or here.

Module Description

CS0278: Sustainability and Innovation Management in an Industrial Context | Sustainability and Innovation Management in an Industrial Context

The transformation of ESG into value and growth

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/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:
Lecture: Written exam (90 minutes): Students have to analyse, assess and discuss (simplified) sustainability / ESG-driven innovation frameworks, processes and product case studies on a local, regional, national and global level. They determine starting points for an optimisation of these concepts and apply them to real-life use cases. Thereby, they have to take different points of view. In doing so, the students have to prove their ability to use the right vocabulary, and their knowledge on the motivation and key figures of sustainably innovation.
Seminar: Intermediate and final team presentations: Student teams have to analyse, assess, discuss and select a certain sustainability/ESG-driven idea/proposal they would like to transform into reality step-by-step.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The module covers the following topics:

• The nature of innovation in its inherent key ingredient: Uncertainty.
• The process of industrial innovation and its various stages
• Tools to manage each stage of the innovation process professionally to reduce uncertainty & risk and improve the performance and results of each stage
• The different levels of industrial innovation and their interdependencies

• The creation and management of innovation portfolios, innovation roadmaps, and innovation projects
• The concept of ESG in sustainability management and various ESG criterions
• Legal and policy frameworks regarding sustainability/ESG such as the European Green Deal
• The impact of sustainability/ESG on performance, shareholder value, and investment decisions
• The introduction of various theoretical frameworks regarding the development of human value systems related to sustainability/ESG
• The introduction and discussion of various broader sustainability/ESG-driven innovation frameworks such as circular economy, sharing economy, sustainable urban mobility, bioeconomy, carbon to value/decarbonization, sustainable energy systems etc.
• Identifying innovation potentials regarding sustainability/ESG inside innovation frameworks, business models, products, systems or components and tools to address these potentials to create value
• The creation and management of sustainability/ESG-related innovation portfolios, road maps and projects
• An interdisciplinary and coached real-life simulation in teams on selected sustainability/ESG-driven innovation ideas/proposals to apply and train the gained knowledge on how to identify promising projects and transform them into successful marketable products.

Intended Learning Outcomes:
Students remember and understand the nature and different stages of industrial innovation and they understand how the transformation from ideas to products can be managed professionally through tools such as innovation portfolios, innovation roadmaps and innovation project management. They understand the several levels of innovations and the strong interdependencies between these levels. They can apply their knowledge to analyse, evaluate the composition of any given business model or product (concept) to identify innovation potentials and to create, analyse, propose and prioritize ideas/proposals that would address these innovation potentials in a way that value can be created.
Students remember and understand the legal and policy frameworks related to sustainability/ESG. They understand the concept of ESG in the context of sustainability management, the various sustainability/ESG criterions and their impact on business performance, shareholder value and investments decisions. They gain an understanding into the development of human value systems and understand why sustainability is a key foundation for the next innovation super cycle that will drive economy and development throughout the next decades.
Based on a deep understanding of the nature of innovation and sustainability/ESG students can evaluate and analyse broader ESG-innovation frameworks such as circular economy, sharing economy, bio economy, sustainable urban mobility, sustainable housing, carbon-to-value/decarbonisation etc. and their practical implications.
Students will be able to apply their knowledge and to create and manage ESG-related innovation portfolios, roadmaps and innovation projects inside existing or new organisations such as start-ups

Teaching and Learning Methods:
Format: lecture and exercises to introduce the content, to repeat and deepen the understanding as well as practice individually and in groups.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies / reading of scientific publications with presentation
- Individual assignments and presentation to consolidate/repeat the learned contents
- Plenary discussions to reflect the lecture contents
- Group work on the transformation sustainability/ESG-driven innovation ideas/proposals
- Design Thinking
- Teams and individual coaching sessions
- Project pitches (Final and intermediary)

Media:
Digital projector, board, flipchart, online contents, case studies

Reading List:
Recommended reading:

• Hauschildt, Jürgen; Salomo, Sören et al: Innovationsmanagement (2016/2023), Vahlen
• Dodgson, Mark; Gann, David: The Oxford Handbook of Innovation Management (2015), Oxford University Press
• Thewes, Rüdiger: Let´s Change a Running System: Transformationswege in eine Nachhaltige Wirtschaft (2021), Tredition
• Christensen, Clayton: The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail (2016), Harvard Business Review Press
• Allianz Global Investors (2010): The sixth kontratieff – long waves of prosperity: https://www.allianz.com/content/dam/onemarketing/azcom/Allianz_com/migration/media/press/document/other/kondratieff_en.pdf
• Mathews, John A.: Greening of Capitalism: How Asia Is Driving the Next Great Transformation (2014), Stanford University Press
• Nefiodow, Leo: The Sixth Kondratieff: A New Long Wave in the Global Economy (2017), CreateSpace Independent Publishing Platform
• Beck, Don Edward; Cowans, Christopher C. : Spiral Dynamics - Leadership, Werte und Wandel: Eine Landkarte für Business und Gesellschaft im 21. Jahrhundert (2020), Kamphausen Media
• Circularity Gap Report Global (2022); https://www.circularity-gap.world/2022
• Osterwalder, Alexander; Pigneur, Yves: Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers (Strategyzer) (2010), Wiley
• Lewrick, Michael : Design Thinking for Business Growth: How to Design and Scale Business Models and Business Ecosystems (2022), Wiley
• https://www.europarl.europa.eu/news/en/headlines/society/20200618STO81513/green-deal-key-to-a-climate-neutral-and-sustainable-eu
• Deloitte: Fit for 55: Maßnahmenpaket der EU zur Umsetzung des Green Deal (2022), Deloitte
• McKinsey: The green business building opportunity (2022), McKinsey
• Peter Lacy, Jessica Long: The circular Economy Handbook: Realizing the Circular Advantage (2020), Wesley Spindler

• UNITED NATIONS SDGS: https://www.undp.org/sustainable-development-goals?utm_source=EN&utm_medium=GSR&utm_content=US_UNDP_PaidSearch_Brand_English&utm_campaign=C
gIVhuJ3Ch3pVQtFEAAYAyAAEgLnGvD_BwE
• EUROPEAN GREEN DEAL: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
• Bardi, Ugo: LIMITS TO GROWTH REVISTED (2011), Springer
• Dixson-Decleve Sandrine; Gaffney, Owen, et al.: EARTH FOR ALL: A Survival Guide for Humanity (2022), New Society Publishers

Responsible for Module:
Prof. Magnus Fröhling

Courses (Type of course, Weekly hours per semester), Instructor:
Sustainability and Innovation Management in an Industrial Context (Vorlesung, 2 SWS)
Fröhling M [L], Seidel M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0279: International Markets of Renewable Energies | International Markets of Renewable Energies

Version [illegible]

Intended Learning Outcomes:
After attending the module, students can characterize different energy markets in the world. These markets will be divided into markets for fossile fuels (e.g. crude oil, natural gas, coal), and in markets for regenerative energy production (e.g. wind, hydro, solar energy, biomass, biogenic by-products). Based on this knowledge, the students can classify, analyze and interpret the results found during the individual group work in a country-specific context. Students understand what influences the selected energy markets and why the markets developed as they did.

Teaching and Learning Methods:
The lecture will be mostly done by presentations. In addition, articles from newspapers, homepages and journals are integrated into the lectures.
In the seminar, the students must investigate selected (renewable) energy markets of a specific country or region doing a scientific literature review on their own. In the elaboration of their project work, students are supported by several feedback meetings and discussions with the instructor.

Media:
Presentations, slide scripts, articles

Reading List:
Word energy outlook of the IEA

Responsible for Module:
Dr. Decker, Thomas

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

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

Module Description

CS0280: Research Internship Method and Process Development for Biotechnology | Forschungspraktikum Methoden- und Prozessentwicklung für die Biotechnologie [PraktMPB]

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:** 60	**Contact Hours:** 240

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

Description of Examination Method:
Following the internship, an internship report is to be written as an examination performance, which on the one hand demonstrates the ability to write scientifically and on the other hand the understanding of the experimental work carried out. The report should follow the IMRAD structure of a scientific publication. (Introduction, material and methods, results and discussion). The length is between 10 and 25 pages, depending on the topic worked on.
In addition, an ungraded presentation of 20 minutes on the results obtained with discussion in the plenum with the supervising lecturers and expert audience should be held to check the communicative competence and presentation of the content.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Attending the lectures “Enzym Engineering” or “Technical Biocatalysis”, both offered in Garching, is beneficial but not mandatory

Content:
The methods and content taught during the practical course depend on the current research topics at the chair. Basically, process, method and apparatus development in the chemical-biotechnological environment are taught, especially for fermentations and enzyme-catalyzed processes.
Exemplary is the topic "Microfluidic high-throughput screening of enzymes" (location Garching).
Here, students learn, among other things:

• Driving microfluidic unit operations such as encapsulation of particles, injection of a continuous phase into droplets (picoinjection), fusion of 2 droplets or fluorescence-based screening of droplets in high throughput (for example of enzyme activity assays).
• Determine optimal process parameters to operate microfluidics for the desired research question
• Design of microfluidic chips using AutoCAD to achieve desired functions
• Analysis of microfluidic generated Big-Data using Python

The internship can be completed - depending on the topic - at campus Garching or TUM Straubing campus.

Intended Learning Outcomes:
By participating in the research internship (6 weeks, whole day), students acquire an in-depth understanding of technical operations and functionalities of biotechnologically relevant apparatus, as well as the ability to develop new methods for chemo-enzymatic processes. The focus is on technical aspects, such as development of new processes, unit operations or identification of optimal process parameters.
The students work preferably in the context of current research projects of the Chair of Chemistry of Biogenic Resources. Through the internship, they gain an insight into the current state of knowledge of the specific field and expand their skills for the targeted planning and execution of research and development work.

Teaching and Learning Methods:
At the beginning, the students are to familiarize themselves with the topic independently in order to obtain an overview of the methods and their application potential for the underlying research question. On this basis, students are to create a processing plan to address the research question. The practical research work will first be carried out under the guidance of the supervisors to ensure that the peculiarities of the sensitive (optical) devices are sufficiently known and that all safety measures (e.g. laser protection or biological safety) are ensured. Subsequently, students should be capable of independent operation of the devices/processes used.
The results produced and the further procedure will be discussed immanently with the supervisors so that hypothesis-guided work and analysis competence are practiced and the dynamic nature of the research process is made clear.

Media:
Presentations by means of PowerPoint and on whiteboard, case descriptions of comparable scientific work as well as computer-aided programs

Reading List:

Responsible for Module:
Prof. Volker Sieber

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Methoden- und Prozessentwicklung für die Biotechnologie (Forschungspraktikum, 16 SWS)
Köllen T, Malubhoy Z, Sieber V
For further information in this module, please click campus.tum.de or here.

Module Description

CS0281: Biopolymers | Biopolymere [Biopol]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	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 learning results are going to be proved in form of a written test (90 min). The students answer questions about biopolymers and their physicochemical properties. They prove that they have gained knowledge about the discrimination, classification and extraction of biopolymers within the scope of the module and are able to apply this knowledge. No additives are allowed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic principles chemistry, physics and biology

Content:
The module deals with the structure and the function of polymers derived from nature (biopolymers). Covered are proteins, polysacharides, biogenic polyester, polyisoprenes and lignin. It is illustrated how bioploymers can be obtained from natural sources and which chemical reactions they are able to perform. Thereby the importance of the microstructure as well as the importance of the physicochemical properties in biological functions for the application-technical relevance of the biopolymers used as raw and functional material are covered.

Intended Learning Outcomes:
By attending the module the students are able to discriminate biopolymers and to classify them application-oriented. They know how and from which natural sources biopolymers can be obtained. The students acquire basic knowledge in the understanding of biopolymers and their physicochemical properties and can describe these properties and compare them among each other. Thereby they are able to differentiate suitable biopolymers application-oriented.

Teaching and Learning Methods:
Teaching methods: in the lecture the technical contents are communicated by a talk of the lecturer, supported by PowerPoint and skectches on the blackboard. In relation to the teaching content written tasks are disbursed on which the students work in self-study before the tutorials. The solution and discussion of the tasks as well as the visulaization of the teaching content by working with molecular models takes place in the tutorials. Learning methods: at the postprocessing of the lecture exspcecially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a comprehensive knowlegde about biopolymers.

Media:
Lecture, blackboard sketch, foil script, molecular models

Reading List:
Türk, Oliver: Stoffliche Nutzung nachwachsender Rohstoffe
Grundlagen - Werkstoffe - Anwendungen, Springer Verlag

Responsible for Module:
Zollfrank, Cordt; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Biopolymere (Seminar) (Seminar, 1 SWS)
Zollfrank C [L], Zollfrank C

Biopolymere (Vorlesung) (Vorlesung, 2 SWS)
Zollfrank C [L], Zollfrank C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0282: Scientific Working | Wissenschaftliches Arbeiten

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Concepts of scientific working shall be practically applied and deepened by the preparation of homework. Homework shall be done as an academic performance and shall not be integrated into the overall performance. Teamwork is possible here. Exam achievement shall be done by a written test. In this test students shall prove that they are familiar with the rules of good scientific working, that they master a methodological approach to planning, execution, evaluation and discussion of a scientific work and that they are able to take a very critical look at experiments, data collection, data processing and evaluations. No tools are allowed. Exam duration: 60 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
As scientific working is essential for all disciplines the module may be attended by students of all kinds of studies.

Content:
The module of scientific working shall impart knowledge for preparing academic theses satisfying a scientific demand. The students discover different methods for scientific working as well as practical working methods and formal guidelines. The course shall illustrate how to prepare the state of knowledge of research as well as topic formulation at the beginning of a scientific work. An important focus of the module is research of literature. Students shall be taught how to handle libraries and quotable sources and shall be explained different possibilities of citation. Form and writing style as well as structuredness and goal orientation (thread) as essential elements of a scientific work shall be part of teaching in the module. Besides independence of participants as well as skills in working collaboratively and taking a very critical look at own results and approaches shall be developed.

Intended Learning Outcomes:
After successfully completing the module the students shall be qualified in preparing a scientific work by well-founded methodological approach. Participants also master a scientifically suitable form and language. They know the laws of good scientific working, correct citation methods and where scientific misconduct results in. In addition the students are able to plan a scientific work and estimate time requirement in a realistic way. Subsequent to this lecture they are able to take a critical look at an experiment and perform data collection, processing, evaluation and discussion.

Teaching and Learning Methods:
Lecture illustrating case studies. In the exercise ... shall be given and the term paper be mentored.

Media:
Presentations, slide scripts

Reading List:
Eco, U.; Schick, W. (2010): Wie man eine wissenschaftliche Abschlußarbeit schreibt (How to Write a Scientific Thesis). Heidelberg: UTB
Heesen, B. (2009): Wissenschaftliches Arbeiten (Scientific working). Vorlagen und Techniken für das Bachelor-, Master- und Promotionsstudium (Templates and Techniques for Bachelor, Master and Doctoral Studies). Berlin: Spinger
Rückriem, G. M.; Stary, J.; Franck, N. (2009): Die Technik wissenschaftlichen Arbeitens (Technique of Scientific Working). Eine praktische Anleitung (A Practical Instruction). Stuttgart: UTB
Davies, M. B. (2007): Doing a successful research project. Using qualitative or quantitative methods. Basingstoke: Palgrave

Responsible for Module:
Dr. Daniel van Opdenbosch

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

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

Module Description

CS0283: Basics Silviculture | Grundlagen Waldbau [BiS]

Versio

Intended Learning Outcomes:
After attending the module the students understand the most important basic forms of forest treatment as well as its ecological special features and the structure and dynamic of forest resources. The students recognize different forest-related tree types and are able to distinguish their demands. After attending this module the students are additionally able to explain different forest soils and different silvicultural farming strategies by using the given information from the fields of forest ecology and location study. Silvicultural techniques shall be recognized and may be used accordingly. The most important forest soil types shall be recognized by means of cross-sections.

Teaching and Learning Methods:
The course of basics of silviculture consists of one lecture, preparing and giving a speech for which material research is necessary and first rhetoric skill are trained. A study trip into the forest and lectures held by qualified personnel from practice on site at different stations with common rounds of questions shall open a deeper insight into the topic. For that purpose also first determination exercises shall be performed at the object in the forest. A cut out soil profile serves to recognize theoretically acquired knowledge of soil horizons.

Media:
In the course the following media forms shall be used:
Script, powerpoint, films, for lectures also blackboard and flipchart, for determination exercises also branches and leaves to be determined. Study trip.

Reading List:
"Burschel, P. & Huss, J. 1987. Grundriss des Waldbaus. Ein Leitfaden für Studium und Praxis. Parey, Hamburg und Berlin. 352 S. Elverfeldt, Freiherr von A.
Rittershofer, F. 1999. Waldpflege und Waldbau. Für Studium und Praxis. Gisela Rittershofer Verlag, Freising. 492 S. "

Responsible for Module:
Dr. Alexander Höldrich

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

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

Module Description

CS0284: Organizational Behavior | Organizational Behavior

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
The examination takes the form of a written, graded exam (60 min). The exam consists of single-choice questions that test knowledge at different levels: Knowledge questions test recall and reproduction of learned concepts, e.g. by reproducing various change management models; Decision questions test the classification or interpretation of learned content, e.g. Application and scenario questions test whether students can apply the content learned in the lectures to practical problems and challenges. The overall grade is determined by the performance in the written examination. It is allowed to use a non-electronic dictionary (English - native language or English Thesaurus) during the exam. Beyond that, no aids such as lecture notes, personal notes, etc. are allowed. There will be mid-term evaluations, which can be included in the exam grade with 0.3.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of business administration

Content:
In accordance with the learning outcomes formulated above, the most important theories and methods of work and organizational psychology are covered. Basic approaches and models of work and organizational psychology are used to understand the behaviour of individual organizational members, teams and entire organizations. In particular, the following aspects are addressed and made theoretically and practically usable: basics of employee management; effects of individual personality traits and motivation in organizations; ethical and moral behavior in organizations; structures and processes in work teams; change management in national and international organizations; organizational culture in national and international comparison.

Intended Learning Outcomes:
After successfully completing the module, students are able to understand and explain key concepts of work and organizational psychology. In addition, students will be able to apply the knowledge they have acquired to practical challenges and problems. Students will be able to recognize and analyze challenges and problems in the areas of employee motivation, teamwork, decision-making behavior and communication. Finally, they are able to recognize and demonstrate practical solutions to HR, change management and ethical problems by applying the theoretical concepts they have learned.

Teaching and Learning Methods:
In the interactive lectures, the most important concepts, approaches and theories as well as their empirical evidence are conveyed and critically discussed with the students. The theoretical and methodological content of the lectures is illustrated using examples and case studies and made usable for practical application. In addition, students are encouraged to engage intensively with the content and to transfer the theories and methods covered through the analysis of instructional videos and through individual tasks and/or work in small groups. Finally, (self-)study of literature is planned.

Media:
Presentations (slides as download)
Videos
if applicable, current international scientific literature (English)
if applicable, case studies

Reading List:
Landy, F.J., & Conte, J.M. (2013). Work in the 21st century. Hoboken, NJ: Wiley.
Wood, J. M. (2016). Organisational behavior: Core concepts and applications. Milton, Australia: Wiley

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Organizational Behavior (WI001121) am Campus Straubing (Vorlesung, 2 SWS)
Goerg S [L], Benzinger D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0288: Strategic and International Management | Strategic and International Management

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Tot□bk**		

Fundamentals and peculiarities of strategic and international management; framework conditions of strategic and international management; theories of international business activities; strategies of internationally operating companies; international dimension of individual business functions; organizational culture in national and international comparison.

Intended Learning Outcomes:
After successful completion of the module, students will be able to understand and explain key concepts of strategic and international management. Additionally, they can apply the acquired knowledge to practical challenges and issues. Students can identify and analyze challenges and issues in the fields of strategic and international management. Ultimately, they are capable of identifying and demonstrating practical solutions to challenges in strategic and international management by applying the learned theoretical concepts.

Teaching and Learning Methods:
In the interactive lectures, the key concepts, approaches, and theories, along with their empirical evidence, are conveyed and critically discussed with the students. Theoretical and methodological lecture contents are illustrated through examples and case studies, making them applicable for practical use. Furthermore, students are encouraged to engage intensively with the content and transfer the discussed theories and methods through the analysis of videos, individual tasks, and/or group work. Finally, self-study of literature is planned as part of the course.

Media:
Lecture slides are available via Moodle.
Current international scientific literature (English)
Case studies
Online discussion forum

Reading List:
Cavusgil, S.T., Knight, G., Riesenberger, J. R. (2008), International Business: strategy, management, and the new realities
Hill, C.W.L. (2014), International business: Competing in the Global Marketplace

Responsible for Module:
Doblinger, Claudia; Prof. Dr. rer. pol. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Strategic and International Management (Vorlesung, 2 SWS)
Doblinger C [L], Doblinger C, Krinner S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0289: Fundamentals of Thermodynamics | Fundamentals of Thermodynamics

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor	**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 exam performance is effected by a written test. The students solve thermodynamical arithmetic problems and answer questions regarding the definitions and relations of thermodynamics. The students prove that they have understood the basic principles of thermodynamics by setting up and solving equations. Non-programmable calculators and a handed-out formulary are allowed aids. Exam duration: 90 minutes.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Mathematics

Content:
State variables, thermodynamic system, 1st and 2nd law, equations of state for ideal gases and fluid of constant density, process cycles, efficiencies, phase diagrams of pure substances

Intended Learning Outcomes:
After sucessful completion of the module the students know the 1st and 2nd law of thermodynamics; the are able to use thermal and caloric equations of state for ideal substance classes; they unterstand thermodynamic phenomena of phase change and related diagrams; they can apply the ideal gas law and the 1st and 2nd law to technical problems.

Teaching and Learning Methods:
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the

module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Presentations, slide scripts, exercises

Reading List:
1. Thermodynamics: Basic Principles and Engineering Applications
Whitman, Alan M.
2nd ed. 2023

2. Fundamentals of Technical Thermodynamics: Textbook for Engineering Students
Dehli, Martin ; Doering, Ernst ; Schedwill, Herbert
1st ed. 2023
2023

Responsible for Module:
Burger, Jakob; Prof. Dr.-Ing.

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

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

Module Description

CS0290: Production of Biogenic Resources | Production of biogenic Resources

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	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:
Exam achievement shall be done in the form of a test. In this test it shall be proved that students are capable of describing important requirement for the required biogenic resources and are capable to devlop important rules for the production of the raw materials in a limited time. On the basis of different examples (e.g. algae productions) and scenarios the students shall discuss pros and cons and the possibilities for the transformation of the different biomass to products.
Type of exam: In writing
Exam duration: 90 min.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The module aims at providing in-depth knowledge to the students in the prodution and cultivation of renewable raw materials. Beside the areal-bound production by agriculture and forest, production processes such as Algae bioreactors where integrated. Differences, advantages and disadvantages and possible perspectives are discussed.
Essential crop characteristics shall be discussed for the treated crops and if required differences shall be addressed by various product use (energy and/or industrial crops). As to crops important performance parameters (yields etc.) shall be debated and integration into a concrete cultivation system (farm) be discussed. For this purpose pros and cons shall be worked out and possible actions shall be discussed for optimizing cultivation. For selected topics current main points of research shall be presented and results discussed.

Intended Learning Outcomes:
After having participated in the module units the students know the most important biogenic ressources for renewable raw materials.
- They are capable of describing important requirement for the required biogenic resources and are capable to devlop important rules for the production of the raw materials
- For the desired raw materials, the required starting materials or biomass can be described (e.g. in the form of agricultural crops (example starch production: cereals, maize)). Based on the agricultural and wood procution of raw materials students can characterize the cropping system and cultivation methods
- They are able to describe possible effects on the environment for selected main crops (cereals, corn, oil crops)
- The students know selected research activities in the field of renewable raw materials and are able to analyse their results concerning their relevance and significance

Teaching and Learning Methods:
The module shall primarily be held as a lecture. For different courses it will be completed by individual and group projects. Demonstration of research activities and presentation of the cultivation by practitioners is partly performed by external guests (lecture, presentation). Further reading and questions for follow-up will be made available for different teaching units in moodle.

Media:
Lecture, presentations, (individual and group projects)

Reading List:
Lütke- 2006: Lehrbuch des Pflanzenbaus, Band 2: Kulturpflanzen, Verlag Th. Mann Gelsenkirchen.
Diepenbrock, Ellmauer, Leon, 2009 : Ackerbau, Pflanzenbau und Pflanzenzüchtung. Ulmer Verlag.
Pflanzenbau, Ein Lehrbuch - Biologische Grundlagen und Technik der Pflanzenproduktion,
Gerhard Geisler, Paul Parey Verlag: Parasitäre Krankheiten und Schädlinge an landwirtschaftlichen Kulturpflanzen, Ulmer Verlag, G.-M. Hoffmann und H. Schmutterer
Diepenbrock 2014: Nachwachsende Rohstoffe, Ulmer UTB, Stuttgart
Kaltschmitt etal. 2009: Energie aus Biomasse, Springer, Heidelberg

Responsible for Module:
Höldrich, Alexander; 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

CS0291: Governance of the Bioeconomy | Governance of the Bioeconomy

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor	**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 will be given in the form of a written examination. The students should be able to name the different actors, measures and potential target conflicts and trade offs based on examples from the lecture and discuss them by means of examples. Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The bioeconomy requires a structural change in a society's operational and economic thinking. This also requires a suitable overall economic regulatory structure (governance) as a framework for action by all economic actors (consumers, politicians, companies, civil society). The design of such framework conditions requires a mix of different instruments (e.g. bans, taxes, standards, subsidies, information) in order to create incentives for structural change. The political framework includes, among other things, climate policy, environmental policy, economic and agricultural policy measures. The course provides an overview of the various actors in the bioeconomy and measures for shaping structural change as well as their economic, ecological and socio-economic effects and trade offs.

Intended Learning Outcomes:
After the event, the students are able to understand the overall economic regulatory structure and identify the respective responsible actors. The students have an overview of the current and potential political measures to promote structural change. Advantages and disadvantages or

possible conflicts of objectives of the control structures in terms of economic, ecological and socio-economic effects can be assessed.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. The lecture takes place using PowerPoint, in which relevant theories and concepts are presented using current examples of governance. Articles and scientific publications from the scientific literature are integrated into the lectures. In the exercise, students develop political governance systems based on examples developed together, present them and discuss the empirical examples individually and/or in groups from different perspectives of the economy.

Media:
Presentations, slide scripts, articles

Reading List:
Paul Krugman and Robin Wells, Microeconomics, 6th Edition, Worth Publishers, 2020, (ISBN 13: 978-1-319-24528-3)
https://seea.un.org/

Responsible for Module:
Faße, Anja; 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

CS0292: Bachelor's Thesis | Bachelor's Thesis

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 300	**Contact Hours:** 0

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

Description of Examination Method:
The Bachelor's Thesis is a final paper with a duration of 3 months, where the students concentrate on a specific topic in business administration and economics. Here the students frame the state of research and discourse and evolves the own specific topic. Based on scientific knowledge and methodical skills, students autonomously discribe the topic.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
120 credits, including all compulsory modules from the first four semesters, according to the module plan of the respective bachelor's program

Content:
The Bachelor's Thesis focuses on a research topic in business adminstration and economics, usually at the interface to engineering and natural sciences. The Thesis is always supervised by a professor, often in co-operation with an organization of industry or research. The topic of the Thesis is created so that it can be treated extensively within three months.

Intended Learning Outcomes:
At the end of the module "Bachelor's Thesis" students are able to handle and develop a project in an autonomic, systematic and scientific way. Therefore the students deploys scientific knowledge and methodical skills to the specific subject. They script the state-of-the-art knowledge, based on research, and classify the findings within the scientific and/or practical discussion. The students are able to cope with new and complex subjects in an autonomous way.

Teaching and Learning Methods:
The creation of the thesis encourages the students to deal soundly with a scientific subject. Therefor they apply the knowledge and methodical skills, acquired during the studies, and create an elaborated scientific documentation within the set time frame.

Media:
Literature, presentations

Reading List:
specific literature based on the topic

Responsible for Module:
Alle prüfungsberechtigten Dozenten/innen des Studienganges

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

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

Module Description

CS0293: VHB - Humanitarian Supply Chain Management | VHB - Humanitarian Supply Chain Management

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** irregularly
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:
written duration: 60 min

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The course will provide you with a basic understanding of factors influencing humanitarian supply chains and fundamental insights in managing them efficiently and effectively. You will learn about the different roles of humanitarian organizations and the challenges they face. Furthermore, you will be introduced to general supply chain management concepts that can also be applied in the humanitarian context, and that can provide a significant positive impact on the organization of humanitarian operations.

Intended Learning Outcomes:

Teaching and Learning Methods:
virtual lecture

Media:

Reading List:

Responsible for Module:
TUMCS Verwaltung VHB - Virtuelle Hochschule Bayern

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

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

Module Description

CS0294: Research Internship Master 5 ECTS | Research Internship Master 5 ECTS

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:** 30	**Contact Hours:** 120

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

Description of Examination Method:
The examination consists of a graded internship report (15-30 pages, depending on the topic) on the contents and contents of the internship results containing at least an overview of the state of knowledge on the project topic as well as the presentation of the working methods used and a presentation of the results with interpretation. In an overall grade, the quality of the familiarisation with the topic, the experimental work, the interpretation of the results and the written elaboration are evaluated.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Background knowledge of the respective focus to which the project topics of the research internships are assigned. In this case, having a background in Python or SuperPro Designer and experience in the laboratory is often recommended.

Content:
Research-related work at the chairs and working groups of the TUM Campus Straubing. The students receive tasks from the research area of the supervising examiner, which they work on under guidance in the form of projects. The subject areas must be able to be assigned to the technical content of the study program. The students plan the project work largely independently under the guidance of the supervisors. The project work consists of 120 working hours, fixed in consultation with the supervisors, usually as a block internship on consecutive weeks, which can be deviated from in consultation. The project work is documented and evaluated in the form of an internship report. In addition, a supplementary presentation of the work progress takes place. The project work can also be done with external institutions, such as companies.

Intended Learning Outcomes:
After participation in the module, students understand the principles of approach to (research)projects in addition to the subject-specific knowledge and working methods taught in the research internship projects, the planning of project work and the critical evaluation of the project results and can apply them to new project tasks. Furthermore, they are able to document, interpret and summarise project work and results in written form.

Teaching and Learning Methods:
Depending on the focus and topic, for example, experiments in laboratories, guided or independent literature and data research, concept studies, simulations, methods for project and experimental design or test evaluation

Media:
Depending on the focus and topic, e.g., experimental equipment (laboratory), databases, libraries, specialized software, programming software, simulation software, project and experimental design software

Reading List:
technical literature;
Davies, M. B. (2007): Doing a successful research project. Using qualitative or quantitative methods. Basingstoke: Palgrave

Responsible for Module:
Zollfrank, Cordt; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Internship Master 5 ECTS (Praktikum, 5 SWS)
Blombach B, Glawischnig E, Hädrich M, Vital S

Research Internship Master 5 ECTS (Forschungspraktikum, 5 SWS)
Costa Riquelme R [L], Costa Riquelme R

Research Internship Master 5 ECTS (Forschungspraktikum, 5 SWS)
Sieber V [L], Abbas Nia A, Al-Shameri A, Arana Pena S, Dsouza Z, Fornoni E, Friedrichs J, Fuchs A, Giustino A, Grundheber J, Hofer N, Hörnschemeyer K, Hupfeld E, Kampl L, Köllen T, Liu Y, Malubhoy Z, Marosevic M, Matena F, Mayer M, Ostertag T, Raga Carbajal E, Rau M, Romeis D, Rühmann B, Scheerer J, Schieder D, Schulz M, Sieber V, Siebert D, Skopp A

Research Internship Master 5 ECTS (Forschungspraktikum, 5 SWS)
Zavrel M [L], Beerhalter D, Borger J, Dsouza V, Geisler N, Marino Jara J, Oktay I, Stegemeyer U, van der Walt H, Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0295: Principles of Life Cycle Assessment | Principles of Life Cycle Assessment

Version of module description: Gültig ab winterterm 2024/25

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:
Written exam (90 minutes): Students have to solve problems from the thematic field of the module. They have to prove their ability to use the right vocabulary, apply their knowledge on principle topics in Life Cycle Analysis and systems thinking and life cycle assessment. Learning aids: pocket calculator.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
none

Content:
The module contains units covering the following topics:
• Principles of life cycle thinking
• LCA following the ISO 14040/14044 and ILCD standards
• Selected Life Cycle Impact Assessment Methods such as for
- Climate Change
- Land use and land use change
- Water use
- Resource use
• Attributional and consequential assessments
• Principles of Multi Criteria Decision Analysis (MCDA)
• Presentation and visualization of results
• Handling of data uncertainty
• Current trends and developments
• Software systems and data bases for material flow analysis and life cycle assessment

• Case study

Intended Learning Outcomes:
The students get an introduction into the principle concepts and tools of life cycle assessment to assess products, services and processes regarding their environmental impacts. Thus, they are able to gain a principle understanding of their underlying material and energy flows and how they impact the environment. With these competencies the development and improvement of systems, products and services can be supported, decision support delivered and communication with stakeholders aided.

Teaching and Learning Methods:
Format: lecture and exercises to introduce the content, to repeat and deepen the understanding as well as practice based on a simple case study.
Teaching / learning methods:
- Media-assisted presentations
- Group work / individual case study
- Computer lab exercises using LCA software systems and Life Cycle Inventory data bases.

Media:
Digital projector, board, flipchart, online contents, case study, computer lab

Reading List:
Recommended reading:
• Curran, M.A. (2015): Life Cycle Assessment Student Handbook, Scrivener Publishing:
• Hauschild, M.Z. & Huijbregts, M.A.J. (2015): Life Cycle Impact Assessment (LCA Compendium - The Complete World of Life Cycle Assessment), Springer.
• Klöpffer, W. & Grahl, B. (2014): Life Cycle Assessment (LCA), Wiley-VCH.
• Recent articles from esp. International Journal of Life Cycle Assessment, Journal of Cleaner Production, Journal of Industrial Ecology, Environmental Science and Technology (to be announced in the lecture)

Responsible for Module:
Röder, Hubert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Principles of Life Cycle Assessment (Exercise) (Übung, 2 SWS)
Röder H [L], Füchsl S, Röder H

Principles of Life Cycle Assessment (Lecture) (Vorlesung, 2 SWS)
Röder H [L], Füchsl S, Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0296: Seminar in Environmental and Development Economics | Seminar in Environmental and Development Economics

Versio

addition to the literature work necessary to answer the research questions, they learn to interpret the necessary empirical analyses
Critically question the results of individual studies and recognize connections between different strands of research.

Teaching and Learning Methods:
In the seminar, the basic principles of academic literature work in the field of environmental and development economics are learned. Students deal with a research topic and summarize the current state of academic research on this topic. They learn to critically question current research results and designs and draw connections between individual studies. The students apply these on their own initiative to a question in their seminar paper. The students present the results of their seminar work to their fellow students and discuss them together in the group. By writing a seminar paper, students learn how to prepare and present a scientific paper on a relevant question.

Media:
Research papers; presentation slides

Reading List:
Valerie Matarese (2013). Using strategic, critical reading of research papers to teach scientific writing: the reading–research–writing continuum, Editor(s): Valerie Matarese (2013). In Chandos Information Professional Series, Supporting Research Writing, Chandos Publishing,Pages 73-89. https://doi.org/10.1016/B978-1-84334-666-1.50005-9.)

Yongyan Li, Margaret Cargill, Xin Gao, Xiaoqing Wang, Patrick O'Connor (2019). A scientist in interdisciplinary team-teaching in an English for Research Publication Purposes classroom: Beyond a “cameo role”,
Journal of English for Academic Purposes, Volume 40, Pages 129-140. https://doi.org/10.1016/j.jeap.2019.06.005.

Yongyan Li, John Flowerdew (2020). Teaching English for Research Publication Purposes (ERPP): A review of language teachers’ pedagogical initiatives, English for Specific Purposes, Volume 59, Pages 29-41. https://doi.org/10.1016/j.esp.2020.03.002.

Responsible for Module:
Prof. Anja Faße

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar in Environmental and Development Economics (Seminar, 4 SWS)
Faße A [L], Faße A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0297: Research Internship Master 10 ECTS | Research Internship Master 10 ECTS

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

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

Description of Examination Method:
The examination consists of a graded internship report (15-30 pages, depending on the topic) on the contents and contents of the internship results containing at least an overview of the state of knowledge on the project topic as well as the presentation of the working methods used and a presentation of the results with interpretation. In an overall grade, the quality of the familiarisation with the topic, the experimental work, the interpretation of the results and the written elaboration are evaluated.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Background knowledge of the respective focus to which the project topics of the research internships are assigned. In this case, having a background in Python or SuperPro Designer and experience in the laboratory is often recommended.

Content:
Research-related work at the chairs and working groups of the TUM Campus Straubing. The students receive tasks from the research area of the supervising examiner, which they work on under guidance in the form of projects. The subject areas must be able to be assigned to the technical content of the study program. The students plan the project work largely independently under the guidance of the supervisors. The project work consists of 360 working hours, fixed in consultation with the supervisors, usually as a block internship on consecutive weeks, which can be deviated from in consultation. The project work is documented and evaluated in the form of an internship report. In addition, a supplementary presentation of the work progress takes place. The project work can also be done with external institutions, such as companies.

Intended Learning Outcomes:
After participation in the module, students understand the principles of approach to (research)projects in addition to the subject-specific knowledge and working methods taught in the research internship projects, the planning of project work and the critical evaluation of the project results and can apply them to new project tasks. Furthermore, they are able to document, interpret and summarise project work and results in written form.

Teaching and Learning Methods:
Depending on the focus and topic, for example, experiments in laboratories, guided or independent literature and data research, concept studies, simulations, methods for project and experimental design or test evaluation

Media:
Depending on the focus and topic, e.g., experimental equipment (laboratory), databases, libraries, specialized software, programming software, simulation software, project and experimental design software

Reading List:
technical literature;
Davies, M. B. (2007): Doing a h h h a

Module Description

CS0298: Applied Ethics for Renewable Resources | Applied Ethics for Renewable Resources

Version of module description: Gültig ab winterterm 2024/25

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:
In a written examination (60 minutes), students relate on fundamental approaches to bioethics. Social issues will translate into students' tasks. Students thereby demonstrate the connections between risks and injustice. Drawing on special scenarios, students will identify areas of conflict and propose possible solutions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Definition of ethics terminology, main schools of thought in approaches to bioethics such as Kantian ethics / deontological ethics
Utilitarianism (theory of consequentialism), liberal individualism (rights-based theory), communitarianism (community-based theory); how bioethical issues are perceived in society, such as
-red gene technology
-green gene technology
-Areas of conflict based on the use of renewable resources: "food before fuel" slogan, exploitation of agricultural land for chemical products or for re-use as energy in light of the world's hunger epidemic. This module will also discuss food waste along the value chain from field to fork.
Legislation laid down in the Convention on Biomedicine (Council of Europe); selected areas of contention such as bioethics for all living creatures; human bioethics; definition of life; definition of death; medical ethics; research; exploitation of resources (production); resource waste (efficiency)

Intended Learning Outcomes:
After completion of the module, students will understand the fundamentals of bioethics. They will be able to gather information on the main schools of thought in approaches to bioethics. Students will have formed their own opinions on aspects of the social issues covered. They will be able to identify issues arising from the production of renewable resources and propose possible solutions using methods learnt in class.

Teaching and Learning Methods:
Lectures teach basic knowledge, presentations, tutorials on practical approches in bioethics, expert lectures on selected topics related to the ethical evaluation of using renewable resources

Media:
script, PowerPoint presentation, documentaries, group work

Reading List:
"Günter Altner: Naturvergessenheit. Grundlagen einer umfassenden Bioethik. WBG, Darmstadt 1991 ISBN 3534800435;
Suhrkamp Taschenbuch Wissenschaft Nr. 1597: Bioethik - Eine Einführung Taschenbuch – 2003 von Marcus Düwell (Herausgeber, Vorwort), Klaus Steigleder (Herausgeber, Vorwort)
European Union, 2014, Health and Consumers. Food. Stop Food Waste. European Commission. Http://ec.europa.eu/food/food/sustainability/index-en.htm [acessed June 6, 2014]
Agrarethik: Landwirtschaft mit Zukunft Gebundene Ausgabe – Juli 2012
von Uwe Meier (Herausgeber)
Energie aus Biomasse - ein ethisches Diskussionsmodell - Michael Zichy, Christian Duernberger, Beate Formowitz, Anne Uhl, Maendy Fritz, Edgar Remmele, Stephan Schleissing, Bernhard Widmann (2011): ""Energie aus Biomasse - ein ethisches Diskussionsmodell"". Darmstadt, Vieweg +Teubner, ISBN: 978-3-8348-1733-4"

Responsible for Module:
Andrea Potzler

Courses (Type of course, Weekly hours per semester), Instructor:
Applied Ethics for Renewable Resources (Lecture) (Vorlesung, 1 SWS)
Potzler A

Applied Ethics for Renewable Resources (Exercise) (Übung, 1 SWS)
Potzler A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0300: Agroforestry Systems | Agroforestry Systems

Version of module description: Gültig ab winterterm 2024/25

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:
Assessment takes a written form (90 minutes). Students show the extent to which they are able to determine practicable and highly economical alley cropping and apply this knowledge to develop solutions to real-life problems. They are also expected to analyze various ecological aspects such as carbon sequestration and erosion protection with the help of introduced examples. Students demonstrate their understanding of the topic when answering questions on crop processing systems.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics in Silviculture

Content:
Role and distribution of agroforestry systems in Germany and all over the world. Introduction to special agroforestry systems for production of renewable resources and their importance. Establishment and use of agroforestry systems. Ecological impact of agroforestry systems: interactions between trees and agricultural systems, competitive relationships, carbon sequestration, CO2 avoidance, erosion protection, dynamics of soil moisture, biomass production, economic evaluation and funding options, propagation and harvesting of appropriate plants, potential applications of crops (e.g. in firing systems).

Intended Learning Outcomes:
Students are able to discuss the ecological and economic potential of agroforestry systems for production of renewable resources. They can evaluate the performance of agroforestry systems and apply concepts for agroforestry systems of typical areas (selection of appropriate wood plants and use systems, localisation of forest belts for optimal performance in the ecosystem). Students

can evaluate agroforestry systems and crop use from a basic economical perspective (efficiency analysis, risks, marketing and strategies for their use).

Teaching and Learning Methods:
Lectures introduce basic knowledge; tutorials on identification of appropriate trees and bushes. Excursion to agroforestry systems in active and trial operations, demonstrating possible damages and causes.

Media:
Lectures given as presentations, examples, group work, case studies

Reading List:
Anbau und Nutzung von Bäumen auf landwirtschaftlichen Flächen Gebundene Ausgabe – Wiley-VCH Verlag GmbH & Co. KGaA; Auflage: 1. Auflage 2009
Tatjana Reeg, Albrecht Bemmann, Werner Konold, Dieter Murach, Heinrich Spiecker;
Kurzumtriebsplantagen: Holz vom Acker - So geht's Taschenbuch – DLG-Verlag, 2012
Dirk Landgraf, Frank Setzer;
Aktuelle Veröffentlichen in Fachzeitschriften

Responsible for Module:
Höldrich, Alexander; 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

CS0301: Advanced Practical Research Experience | Advanced Practical Research Experience

Version of module description: Gültig ab summerterm 2024

Module Level: Master	Language: German/English	Duration: one semester	Frequency: winter/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:
Grading is based on a project work. The project work consists of a written project report. The student works on a specific problem set. The student runs through several project stages: problem definition, division of work/tasks, decision-making processes, and realization. Throughout this process, the student shows that she/he can develop appropriate strategies to cope with the set of problems. She/he shows the ability able to compose the state of research. In addition, she/he demonstrates the ability to develop their own specific approach for a solution based on scientific knowledge as well as methodical skills.
Grading will especially take into account the overall working outcome of the project with respect to the initial problem set, the selection and application of the chosen methodology as well as the analyses and discussion of the main findings. The project work is set up in a way, which enables the identification and evaluation of each student's individual contribution to the project's success.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Advanced knowledge in concepts of Management and Business Administration
Operations Research (CS0098)
Advanced Modelling and Optimization (CS0170)
Advanced Seminar in Supply and Value Chain Management (CS0112 or CS0090)

Content:
The research study consists of a specific problem statement or challenge. This challenge may have a research related or practical character. The research project and its findings regarding the outlined problem set are based on students' academic knowledge gained through their study programs. Examples of topics covered in the context of a include (non-exhaustive list) for example

analyzing potential sales volumes with data mining techniques, identifying potential optimization actions or developing algorithms for certain business problems.

Intended Learning Outcomes:
After successful participation in the module, students are able to work on sophisticated research projects in a systematic and academic manner. Students are able to complete a research project in particular in identification research gaps, developing research questions, selecting appropriate research methods and apply them to actual research problem. Students obtain capabilities to deepen and apply theoretical concepts to the identified problem set and develop their analytical solution finding skills. Students become able to manage resources, and deadlines through timely submission of the enumerated tasks in stages throughout their research projects.

Teaching and Learning Methods:
The development of the solution of the research question encourages the students to deal soundly with an academic subject based on their previously acquired academic knowledge. The project may happen at the premises of a respective company/institution or from a remote location. Participants are able to communicate the evolvement of the project by composing a project report and preparing a presentation of their solutions to the supervisors. With regards to content, the research study takes an approximate time of 6-8 weeks.

Media:
literature, presentations

Reading List:
Project Management Institute (2013): A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fifth Edition
Further literature based on the specific topic

Responsible for Module:
Hübner, Alexander; Prof. Dr. rer. pol.

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

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

Module Description

CS0302: Research Internship Bachelor | Research Internship Bachelor

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**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:
Next semester

(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

CS0303: Accredited Module 1 ECTS | Anerkanntes Modul 1 ECTS

Version of module description: Gültig ab summerterm 2024

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

CS0303-2: Accredited Module 1 ECTS | Anerkanntes Modul 1 ECTS

Version of module description: Gültig ab summerterm 2024

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

CS0304: Research Excursion Bachelor | Research Excursion Bachelor

B-REX

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**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:
Passed/not passed:
The module is passed when the deliver a learning portfolio consisting of the following elements:
1. 2 written pages or 20' presentationon preparatory work for the excursion. The form and the due date will be specified in the kick-off session.
2. At least two topical contributions to the excursion (topical input, interviews, questions on presentations and during site visits, discussion contributions);
3. 2 written pages reflection after excursion. The due date will be specified in the kick-off session.
All three elements of the learning portfolio have to be delivered to pass the module.

Repeat Examination:

(Recommended) Prerequisites:
Prerequisites may be defined by the professors / lecturers offering the excursion, dependent on the chosen destination / topic. They will be announced with the announcement of the excursion 1 month before the start of lectures in the semester in which the excursion is offered, at the latest.

Content:
The research excursion deals with individual and specific topics from the respective study programmes. On an individual basis, professors and lecturerers from the rerspective study programme offer the research excursion to a topic or place of their choice.

A bullet point list with typically 10-12 entries will be provided by the professors and lecturers with the announcement of the research excursion 1 month before the start of lectures in the semester in which the excursion is offered, at the latest.

Intended Learning Outcomes:
The excursion aims to support the scientific profile building of students and the acquisition of scientific, practical and social competencies. It supports the competence acquisition in other modules and / or the study programs in general. The students get practical insights into the topical field of the research excursion, deepen their comptencies in this field regarding ongoing research and its tranferability into practice.

In particular, the intended learning outcomes are the following:
- Select relevant scientific and practical information and recall it for visits of industries, organizations, cities and talks with experts and stakeholders,
- Prepare questions regarding the state-of-knowledge, open research questions and practical relevance and discuss these with fellow students,
- Discuss research and practical knowledge with stakeholders,
- Recognize the implementation of research and practical knowledge in the organisations / sites visited,
- Reflect on the state of implementation of theoretical knowledge in practice,
- Discuss with fellow students and supervisors gained insights and compare it with their expectations.

Teaching and Learning Methods:
The research excursion consists typically of the following elements (teaching and learning methods):
- Kick-off session: To achieve a good get-to-know, brief the students about the research excursion contents, related courses and required student performance an interactive in-presence workshop will be carried out. This covers prsentations, and interactive elements such as games, online-tools etc.
- Individual work and feedback: In order to prepare for the on-site visits the students carry out own (literature) research on the excursion topics. To document their learning progress and to be able to share the results they summarize their findings in written form. A presentation of the contents in front of the fellow students is an optional element. In this process, they are supervised, receive materials and continuous feedback.
- On-site visits: 3-5 day research trip with site-visits, presentations, discussions with stakeholders etc.This part will be specified in the specific program of the research excursion and can due to the variety of possible destinations and topics not be specified further at this point.
- Individual work: the students will reflect their learnings in written form.

Media:
Digital projector, board, flipchart, online contents, recent scientific journal publications, equipment and utilities demonstrating production processes in practice

Reading List:
Topic related reading, especially articles in international peer reviewed journals, will be provided during the course of the module.

Responsible for Module:
Prof. Cordt Zollfrank Prof. Hubert Röder Prof. Magnus Fröhling

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

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

Module Description

CS0305: Research Excursion Master | Research Excursion Master

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**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:
Passed/not passed:
The module is passed when the students deliver a learning portfolio consisting of the following elements::
1. 2 written pages or 20’ presentation on preparatory work for the excursion. The form and the due date will be specified in the kick-off session.
2. At least two topical contributions to the excursion (topical input, interviews, questions on presentations and during site visits, discussion contributions;
3. 5-10 PPT slides reflecting the findings based on a case study visited during the excursion. The due date will be specified in the kick-off session;
4. Final report of case studies and results of the workshop;

All four elements of the learning portfolio have to be delivered to pass the module.

Repeat Examination:

(Recommended) Prerequisites:
Prerequisites may be defined by the professors / lecturers offering the excursion, dependent on the chosen destination / topic. They will be announced with the announcement of the excursion 1 month before the start of lectures in the semester in which the excursion is offered, at the latest.

Content:
The research excursion deals with individual topics from modules and / or the study programs for which it is designed. On an individual basis, professors and lecturerers from these modules / study programs offer the research excursion to a topic or place of their choice.

A bullet point list with typically 10-12 entries will be provided by the professors and lecturers with the announcement of the research excursion 1 month before the start of lectures in the semester in which the excursion is offered, at the latest.

After the excursion the results of the applied methodologies are presented and discussed in a workshop. Key findings and the results of the workshop are included in a final excursion report by the students.

Intended Learning Outcomes:
The excursion aims to support the scientific profile building of students and the acquisition of scientific, practical and social competencies and the application to case studies visited during the excursion. It supports the competence acquisition in other modules and / or the study programs in general. The students get practical insights into the topical field of the research excursion, deepen their comptencies in this field regarding ongoing research and apply their competencies to real case studies in practice.

In particular, the intended learning outcomes are the following:
- Select relevant scientific and practical information and recall it for for visits of organizations, cities and talks with experts and stakeholders,
- Prepare questions regarding the state-of-knowledge, open research questions and practical relevance and discuss these with fellow students,
- Discuss research and practical knowledge with stakeholders,
- Recognize the implementation of research and practical knowledge in the organisations / sites visited,
- Reflect on the state of implementation of theoretical knowledge in practice,
- Discuss with fellow students and supervisors gained insights and compare it with their expectations,
- Perform structured interviews and talks with experts and stakeholders in practice
- Apply methodologies from theoretical lectures and exercises on practical organizations

Teaching and Learning Methods:
The research excursion consists typically of the following elements (teaching, learning and application of methods):
- Kick-off session: To achieve a good get-to-know, brief the students about the module contents, course and required performance an interactive in-presence workshop will be carried out. This covers presentations, and interactive elements such as role games etc.
- Individual work and feedback: In order to prepare for the on-site visits the students carry out own literature research on the excursion topics. To document their learning progress and to be able to share the results they summarize their findings in written form. A presentation of the contents in front of the fellow students is an optional element. In this process, they are supervised, receive materials and continuous feedback.
- On-site visits: 3-5 day research trip with site-visits, presentations, discussions with stakeholders, interviews of experts etc. This part will be specified in the specific program of the research

excursion and can due to the variety of possible destinations and topics not be specified further at this point.
- Individual work: the students will reflect their learnings in written form,
- Workshop: the students will present and discuss their findings in a workshop to gain practical experience for their future working conditions and formulate a final excursion report.

Media:
Digital projector, board, flipchart, online contents, recent scientific journal publications, equipment and utilities demonstrating production processes in practice

Reading List:
Topic related reading, especially articles in international peer reviewed journals, will be provided during the course of the module.

Responsible for Module:
Prof. Cordt Zollfrank Prof. Hubert Röder Prof. Magnus Fröhling

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

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

Module Description

CS0313: Biogas Technology | Biogas Technology [BiGA]

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 100	**Contact Hours:** 50

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

Description of Examination Method:
Students take a written examination (90 minutes) to demonstrate their knowledge of microbial breakdown processes in the biogas process, as well as their ability to assess influencing factors. They also demonstrate their knowledge of various technologies for using biogas and can explain their respective advantages and disadvantages. Additionally, they demonstrate that they have understood the legal and economic framework conditions of biogas technology and are able to translate these to case examples. Students also show that they can develop basic concepts of biogas plants.They will answer questions on the topic in their own wording and explain case examples or work out calculations. Multiple-choice questions are also possible.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Required: basic knowledge in biology, especially microbiology, as well as general and organic chemistry, mathematics, physics and thermodynamics of cycles; of advantage: knowledge in agriculture and agricultural engineering

Content:
Microbiology of biogas processing, anaerobic substrate breakdown, factors influencing the fermentation process, process management strategies, biogas storage and purification; biogas recovery (e.g. use of a motor for power generation with or without the use of heat or feeding into the gas grid); legal-economic framework conditions; sustainability issues; competition for raw material and acceptance of biogas plants; aspects of biogas plant design.

Intended Learning Outcomes:
After successful completion of the module, students are able to develop concepts for biogas generation and recovery in a specific context. Students are aware of microbial breakdown

processes in biogas plants and can differentiate between various influencing factors. They are also aware of various processes for the use of biogas and understand their advantages and disadvantages. Students recognize the meaning of biogas technology for sustainable energy supply. Students have a good knowledge of legal and economic framework conditions in the field of biogas generation and they are able to conceptualize basic biogas plants.

Teaching and Learning Methods:
Lectures given as presentations, with the help of a blackboard and interactive elements, in particular group work on case examples; optional: excursion to a biogas plant to deepen acquired knowledge in a real-life setting

Media:
PowerPoint presentation, slide notes, exercise sheets

Reading List:
D. Deublein, A. Steinhauser, Biogas from Waste and Renewable Resources - An Introduction, Wiley-VCH, 2010, ISBN-13: 978-3-527-32798-0, ISBN-10: 3-527-32798-3

Responsible for Module:
Schieder, Doris; 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

CS0315: Business Planning and Valuation | Business Planning and Valuation

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/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:
Achievement of desired learning objectives shall be verified in a written final exam and an oral presetation. In the oral test, the foundations of business analysis and planning are presented by the students based on a case example. In the written examination the students calculate key indicators of business analysis and business plan concepts and evaluate and declare the contents of business plans. This examines whether the students can apply the learned contents of business analysis and planning in their own words. The written final exam shall be integrated into the general assessment by 75% and the oral presentation by 25%.

Type and duration of exam: In writing (60 min) and oral (20 min);

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The "business analysis" lecture includes economic analysis methods based on selected business areas of renewable resources and a case study (e.g. biomass CHP) including the impact of changing business framework.

The "businessplan" exercise provides an introduction to the process of creating a business plan exemplarily by establishing a company. The topics are divided into the following areas:
1. Definition Entrepreneurship
2. Entrepreneurial opportunities and implementation

3. The person of the entrepreneur
4. Innovation and Entrepreurship
5. Business strategy and model
6. Marketing and market orientation
7. Start-up financing
8. Growth and Exit
9. Business Plan

Intended Learning Outcomes:
Upon successful completion of this module, the students understand the general framework of business analsyis and planning and are able to understand and apply these methods in practice. Furthermore, students' entrepreneurial thinking is encouraged. In addition, students are able to evaluate existing business plans and to formulate a well structured business plan based on their business ideas.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. During the lectures the contents are delivered by presentations and discussions primarily as seminaristic dialogue. The lectures are used to convey the theorectical foundations and include conducting some exercises. The students are inspired to improve the acquired knowledge by studying the suggested literature. In the exercises students apply the acquired knowledge in solving exercises and implementing case studies which also include roll playing. Students deepen their understanding through working in small student groups as well as solving exercises on their own. Team work and role playing supports the training of practical application of the lessons learnt and ability to work in teams.

Media:
PowerPoint, script, whiteboard, exercise sheets, reader;

Reading List:
KALTSCHMITT, M., STREICHER, W. und A. WIESE (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Springer; Auflage: 5. Aufl. 2013.
Quaschnig, V.: Regenerative Energiesysteme: Technologie – Berechnung – Klimaschutz. Carl Hanser Verlag GmbH & Co. KG; 10. Aufl. 2019
Fueglistaller et al. (2012), Entrepreneurship - Modelle - Umsetzung - Perspektiven. Springer Gabler Verlag. Wiesbaden;
Evobis Handbuch Businessplan-Erstellung. www.evobis.de;
Faltin (2008), Kopf schlägt Kapital. Carl Hanser Verlag. München;
Oehlrich (2013), BWL – Eine Einführung am Businessplan-Prozess. Verlag Franz Vahlen München.

Responsible for Module:
Röder, Hubert; Prof. Dr.

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

Business Planning (Übung, 3 SWS)
Röder H [L], Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0316: Bioprocess Scale-Up | Bioprocess Scale-Up [BSU]

Bioprocess Scale-up

Version of module description: Gültig ab winterterm 2024/25

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:
The learning content is checked by means of a written examination on the learning outcomes of the module. The written examination lasts 60 minutes. Using questions on terms and methods of scaling up bioprocesses, the students show that they know the relevant technical terms, names and content, that they have understood the basic relationships and can apply their knowledge. Using calculations, the students also show that they can calculate the scale up.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bioprocess Engineering
Conceptual Design of Bioprocesses

Content:
Biopharmaceuticals, enzymes, biological cell materials or food supplements are all derived from the cultivation of bacteria, yeasts, fungi, plant or animal cells in bioreactors. Regardless of what kind of bioprocess is used for, efficiencies of time and cost and other resources are major factors to consider. These bioprocesses are usually developed at small laboratory scale. Later, the established processes are stepwise transferred to larger volumes until the commercial industrial production-scale is reached. This procedure is known as scale-up.
To reach this goal different scale-up strategies can be applie Ts aiacdes of this coues

various strategies introduced. Finally, emerging trends and challenges will be discussed. Through a combination of theoretical concepts, practical examples, and real-world case studies, this lecture aims to enable participant to develop suitable scale-up strategies in future.
By the end of this lecture, participants will be equipped with the knowledge and insights necessary to navigate the challenges and seize the opportunities presented in the field of bioprocess scale-up.

Intended Learning Outcomes:
Upon completion of the course, the students are able to:
- Know fundamentals of scaling-laws
- Know fundamentals of scale-up strategies
- Have necessary knowledge and tool-sets for scaling-up bioprocesses
- Be aware of potential pitfalls during scale-up
- Know best practices for scale-up

Teaching and Learning Methods:
The lecture is mainly conducted as frontal teaching in order to familiarize the students with all the necessary basics that they need for the scale-up of sustainable processes in the field of biotechnology. Calculation exercises are included into the lecture.

Media:
Slides, interactive quiz, films, script, exercises

Reading List:
Marko Zlokarnik, Dimensional Analysis and Scale-up in Chemical Engineering, https://doi.org/10.1007/978-3-642-76673-2

Responsible for Module:
Zavrel, Michael; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Bioprocess Scale-Up (Vorlesung mit integrierten Übungen, 2 SWS)
Zavrel M [L], Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

CS105BOK: Public Relations - Fundamental Rules and Conception | Grundregeln und Konzeption der Öffentlichkeitsarbeit

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
a) Presenting a PR-example; necessary for attending the exam; detailed information will be given in the first lesson b) test c) participation / activity

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The public relations concept - terms and definitions, fundamental rules of modern public relations, target groups, conception of public relations, tools of public relations (PR-measurements), crisis-PR, internal PR

Intended Learning Outcomes:
Learning how to create strategic public relations concepts

Teaching and Learning Methods:
lecture with exercises

case studies
problem based learning

Media:

Reading List:

Responsible for Module:
BOKU - Institut für Wald-, Umwelt- und Ressourcenpolitik

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

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

Module Description

WZS0001: Physics | Physik

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**Language:** German	**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:
Achievement of desired learning objectives shall be verified in a written final exam (90 minutes). In this respect the students demonstrate that they know and understand the concepts of mechanics, thermal engineering, electricity and optics. By using specific physical issues (mainly computational tasks) the students demonstrate that they are able to also use acquired concepts in a solution-oriented way in simple cases.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Good A-level knowledge of mathematics

Content:
The module of physics provides an introduction into classical physics; it outlines the basics of mechanics, thermal engineering, electricity and optics. The module introduces into the math-based approach of physics for nature description.

Intended Learning Outcomes:
After participation of the module students can demonstrate physical basics. The students know the basic concepts of mechanics, thermal engineering, electricity and optics. Using examples students deepen in the exercise the application of this concepts to solve simple physical problems.

Teaching and Learning Methods:
Lecture (speech by teaching staff including writing on the board, PP media, books and other written material), exercise (self-employed work on exercises related to the topics of the lecture in small groups with tutors) for further practising of the concepts which were presented in the lecture.

Media:
Writing on the board, presentations, slide scripts

Reading List:
U. Harten: Physik, Einführung für Ingenieure und Naturwissenschaftler (Physics, Introduction for Engineers and Scientists), 4th edition 2009, Springer
Paul A. Tipler: Physik (Physics), Spektrum (Panoply), Akademischer Verlag Heidelberg, Berlin, Oxford

Responsible for Module:
Josef Kainz

Courses (Type of course, Weekly hours per semester), Instructor:
Physics (Lecture) (Vorlesung, 2 SWS)
Kainz J [L], Kainz J

Physics (Exercise) (Übung, 2 SWS)
Kainz J [L], Kainz J, Sun J
For further information in this module, please click campus.tum.de or here.

Module Description

WZS0002: General and Inorganic Chemistry | Allgemeine und anorganische Chemie

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**Language:** German	**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 performance test will be in the form of a written examination rendered. The students should demonstrate in the exam the understanding of the structure of chemical compounds and their typical reactions and chemical conversions. It will also be tested the ability to formulate reaction equations, calculate reaction kinetic and thermodynamic parameters, as well as to transfer the acquired knowledge about the structure and reaction behavior of chemical substance groups to new chemical questions. No auxiliary means are allowed in the exam. 120 min examination time

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of chemistry, mathematics and physics, which correspond to the basic course knowledge of the gymnasiale upper school

Content:
General principles of inorganic and physical chemistry: Atomic and molecular construction, structure of compounds, acid / base equilibria, redox reactions, thermodynamics,reaction kinetics and catalysis, fundaments on electrochemistry, selected reactions of inorganic chemistry

Intended Learning Outcomes:
The students will know and understand the basic principles of chemical reactions and will be able to formulate correct reaction equations and simple reaction kinetic and thermodynamic calculations. Moreover, they will be able to apply the knowledge acquired with model reactions about chemical transformations of chemical substances and substance groups to answer new chemical questions. The successful participation in the module will enable the students to participate in the module of basic organic chemistry.

Teaching and Learning Methods:
Lectures and corresponding exercises with self analysis and workup of specific case studies. In relation to the teaching content exercise sheets are disbursed on which the students work in self-study before the tutorials. The solution and discussion takes place in the tutorials. At the postprocessing of the lecture exspecially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the structure and reaction behavior of chemical substance groups and practise the formulation of reaction equations.

Media:
Blackboard, presentation (using script), exercises.

Reading List:
1) Theodore L., H. Eugene LeMay, Bruce E. Bursten, Chemie Studieren Kompakt, 10. aktualisierte Auflage, Pearson Verlag, München;
2) Charles E. Mortimer, Ulrich Müller, Chemie, 10., überarbeite Auflage, Thieme Verlag, Stuttgart

Responsible for Module:
Olga Garcia Macheño

Courses (Type of course, Weekly hours per semester), Instructor:
Allgemeine und anorganische Chemie / Angleichung Chemie (Vorlesung) (Vorlesung, 2 SWS)
Riepl H [L], Riepl H

Allgemeine und anorganische Chemie (Übung) (Übung, 2 SWS)
Riepl H [L], Riepl H
For further information in this module, please click campus.tum.de or here.

Module Description

WZS0003: Organic Chemistry | Grundlagen der organischen Chemie

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**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 performance test will be in the form of a written examination rendered. The students should demonstrate in the exam the understanding of the structure of organic chemical compounds and their typical reactions and chemical conversions. It will also be tested the ability to formulate reaction equations, as well as to transfer the acquired knowledge about the structure and reaction behavior of organic chemical substance groups to new chemical questions. No auxiliary means are allowed in the exam. 120 min examination time

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of chemistry, mathematics and physics, which correspond to the basic course knowledge of the gymnasiale upper school

Content:
General principles of organic chemistry:
Structure of organic compounds, carbon-atom hybridization, important functional groups, nomenclature and structure of organic molecules, selected reactions of organic chemistry for important groups of substances including central natural substances.

Intended Learning Outcomes:
The students will know and understand the basic principles of organic chemical reactions and will be able to formulate correct organic reactions. Moreover, they will be able to apply the knowledge acquired with model reactions about chemical transformations of organic chemical substances and substance groups to answer new chemical questions.

Teaching and Learning Methods:
Lectures and corresponding exercises with self analysis and workup of specific case studies. In relation to the teaching content exercise sheets are disbursed on which the students work in self-study before the tutorials. The solution and discussion takes place in the tutorials. At the postprocessing of the lecture exspecially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the structure and reaction behavior of organic chemical substance groups and practise the formulation of reaction equations.

Media:
Blackboard, presentation (using script), exercises, laboratory equipment.

Reading List:
K.P.C. Vollhardt, N.E. Schore, Organische Chemie, Verlag VCH Weinheim

Responsible for Module:
Olga Garcia Mancheño

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung Organische Chemie (2 SWS)
Übung Organische Chemie (2 SWS)
Olga García Mancheño, Herbert Riepl
For further information in this module, please click campus.tum.de or here.

Module Description

WZS0005: Forestry and Wood | Forst und Holz

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**Language:** German	**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:
Exam achievement shall be done in the form of a written test (exam duration: 90 minutes). Product pathways of timber harvest shall be reflected here. Classification of economic and ecological aspects of forestry from cultivation to harvesting shall be explained by using examples of particular cases. Recognition of wood and wood materials shall be shown. The relation of knowledge of the forest with regard to knowledge of different woods and wood utilisation will be evaluated at a ratio of 1 to 1. The answers require own formulations from the respective technical jargon of the timber industry.
Type of exam: In writing

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in silviculture: Different thinning concepts. Location differences with their effects on selection of tree species.

Content:
The module aims at providing in-depth knowledge to the students in the field of timber harvest, from working methods to forest basics. Special emphasis is given to the interfaces concerning wood use (sawing, wood materials and paper industry) of energy wood production. The differences of farming systems of plantation, commercial forest, near-natural forest and the effect on biodiversity shall be shown. In a further aspect differences of woods shall be addressed from a microscopic point of view through to their field of application in the manufacturing industry. Silviculture as a result of climate change with new forms of cultivation such as short-rotation plantations and their combinations such as hedges, hedgerow substitution in the sense of agro-forestry models shall be presented. This also includes knowledge of by-products such as roadside planting as a raw material.

Intended Learning Outcomes:
After attending the module the student shall be able to characterise the product pathways in forestry especially for timber harvest. He will be able to represent forestry-related working methods. He distinguishes different forms of economy and is able to classify them according to economic, social and ecological aspects. He recognises differences of woods, knows various new products produced from wood and understands their production paths. He is able to mention by-products and their applications and use. He understands the main features of agro-forestry systems.

Teaching and Learning Methods:
The course attendance of forestry and wood consists of one lecture. For this purpose a powerpoint presentation shall be used. A study trip to a wood processing plant including lectures from qualified personnel providing information from experience on site with common rounds of questions provides in-depth knowledge of the production paths. A so-called block determination, i. e. the determination of wood by means of different genuine wood samples, will be performed by a magnifying glass 10x.

Media:
Script, powerpoint, objects of wood and derived timber products. Study trip to a company with guided tour of processing and treatment of wood. Determination of wood with a magnifying glass 10x.

Reading List:
Jörg van der Heide, 2011: Der Forstwirt. Verlag: Ulmer (Eugen); Auflage: 5. Auflage. (26. September 2011)
Sprache: Deutsch
ISBN-10: 3800155702
ISBN-13: 978-3800155705; D. Fengel, G. Wegener: Wood Verlag Kessel, www.forstbuch.de
Holger Sohns, 2012: Moderne Holzernte. Ulmer Verlag
Michael Paulitsch und Marius C Barbu, 2015: Holzwerkstoffe der Moderne. DRW Verlag

Responsible for Module:
Cordt Zollfrank (cordt.zollfrank@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Wood-based Resources (Exercise) (Übung, 2 SWS)
Zollfrank C [L], Röder H, Zollfrank C

Wood-based Resources (Lecture) (Vorlesung, 2 SWS)
Zollfrank C [L], Röder H, Zollfrank C
For further information in this module, please click campus.tum.de or here.

Module Description

WZS0006: Introduction into Computer Science | Einführung in die Informatik

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**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:
Exam achievement shall be done in the form of a written test (90 minutes). Knowledge questions check the treated basic concepts of computer science. Small programming and modelling tasks test the ability to apply the learned programming and query languages and the modelling techniques in order to solve simple problems.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Recommended prerequisites: Modules Mathematics I (TUM-BWL) and Management Science

Content:
In the module following contents are treated exemplarily:
- database management systems, ER modelling, relational algebra and SQL
- Java as programming language:
o Basic constructs of imperative programming ((if, while, for, arrays etc.)
o Object-oriented programming (inheritance, interfaces, polymorphism etc.)
o Exception handling and generics basics
o Code-Conventions
o Java class library
- Basics of Visual Basic for Applications
- Basic algorithms and data structures:
o Algorithm term, complexity
o Data structures for sequences (linked lists, arrays, stacks & queues)
o Recursion
o Hashing (chaining, probing)

o Search (binary search, balanced search trees)
o Sorting (Insertion-sort, selection-sort, merge-sort)

Intended Learning Outcomes:
After successful participation in this module students will be able to understand important basic terms, concepts and thinking of computer science, especially object-oriented programming, databasis & SQL, and basic algorithms and data structures.They are enabled to develop own programms. Students are able to apply database connections.

Teaching and Learning Methods:
Lecture and practical exercises: In addition to a central exercise,
in which the concepts of the lecture were deepend on the basis
of examples, tutorials, in which simple tasks were solved on the computer under intensive support, impart important practical
basic skills of programming, in order to apply the self-study acquired knowledge. In the second half of the semester
students work on a practical project, that should deepen the
related unterstanding with regard to the desired learning
outcomes.

Media:
Slide presentation, blackboard, lecture and exercice recording, discussion forums in e-learning platforms; Working on the PC

Reading List:
Heinz-Peter Gumm, Manfred Sommer, 2012, Einführung in die Informatik, Degruyter Oldenbourg
Marco Emrich, 2013, Datenbanken & SQL für Einsteiger, Create space independent publishing platform

Responsible for Module:
Dominik Grimm (dominik.grimm@hswt.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Foundations of Programming (Exercise) (Übung, 2 SWS)
Grimm D [L], Eiglsperger J, Martello S

Foundations of Programming (Lecture) (Vorlesung, 2 SWS)
Grimm D [L], Grimm D
For further information in this module, please click campus.tum.de or here.

Module Description

WZS0008: Physical Chemistry | Physikalische Chemie

Version of module description: Gültig ab winterterm 2017/18

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

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

Description of Examination Method:
The learning results are going to be proved in form of a written test (120 min). The students solve physical/chemical arithmetic problems and answer questions for definitions or physical/chemical relations. They prove that they have understood the basic relations of physical chemistry that are highlighted within the scope of the module and can use the systems of equations. Calculators are allowed additives. Other additives can be permitted by the lecturer as needed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A-level student knowledge of mathematics (especially differentiation and integration) and physics

Content:
Basics of chemical thermodynamics: laws of thermodynamics, forms of energy (U, H, G, S), relations of formulas; chemical equilibrium and chemical reactions; properties of gases; phase transition of pure substances and multiphase systems; two component systems; selected boundary surface phenomena; basics of reaction kinetics

Intended Learning Outcomes:
After successful completion of the module the students know the laws of thermodynamics; they are able to make calculations concerning U, H, S and G; they understand phase diagrams of one and two component systems, can create charts and calculate the condition of equilibrium of simple systems; they can calculate with partial molar quantities in multi component systems; they can use ideal and real gas equations; they are able to form and solve equations related to the kinetics of chemical reactions and to determine the order of reactions;

Teaching and Learning Methods:
Teaching methods: in the lecture the teaching content is communicated by a talk of the lecturer, supported by PowerPoint and sketches on the blackboard in which the latter form is chosen to derivate complex relations. To a limited extent this can be completed for selected topics by self-study of the textbook by the students. In relation to the teaching content exercise sheets are disbursed on which the students work in self-study before the tutorials. The solution and discussion takes place in the tutorials. Learning methods: at the postprocessing of the lecture especially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the physical-chemical relations and practise the usage of the systems of equations.

Media:
PowerPoint, whiteboard, exercise sheets, textbook, optional: script

Reading List:
Lehrbuch: P.W. Atkins, J. de Paula, Physikalische Chemie, 5. Auflage, Wiley-VCH, 2013

Responsible for Module:
Prof. Nicolas Plumeré Dr. Doris Schieder

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

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

Module Description

WZS0012: Bioprocess Engineering | Bioverfahrenstechnik

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**Language:** German	**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 teaching content will be evaluated by a written examination for the learning outcomes of the module. The contents of the module will be checked by calculations and using diagrams.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bascis in Mathematics, Physics, Biochemistry, Chemistry, Physical Chemistry, Chemical Thermodynamics and Material Transport

Content:
The lecture provides a fundamental overview of bioprocess engineering including all relevant process parameters, calculations and balances.This includes basic calculations of generation times, maximal specific growth rates as well as balancing of batch, fed-batch and continous fermentation processes. Furthermore, process relevant parameters such as oxygen transfer rates and heat transfer will be conveyed. Additionally, basic operation unit design as well as scale-up aspects will be examined.

Intended Learning Outcomes:
After attending the module the students can define detailed and differentiated knowledge about concepts of various bioprocesses. Finally they are able to describe, calculate and design classical as well as complex bioprocesses. They will be able to evaluate the applicability of mathematical modelling of bioprocesses and will use this knowledge to analytically simplify highly complex process variants.

Teaching and Learning Methods:
The lecture will be peromed as ex-cathedra teaching to provide the students will all necessary fundamentals. Within the tutorial the students learn how to transfer this knowledge and get practically used with the content of the lecture. The tutorial will be used to internalise the theoretical knowledge based on case studies which allows the transformation on real-world as well as highly specific challenges of bioprocesses.

Media:
PowerPoint, short films, scripts, exercise sheets

Reading List:

Responsible for Module:
Matthias Gaderer

Courses (Type of course, Weekly hours per semester), Instructor:
Bioverfahrenstechnik (Übung) (Übung, 2 SWS)
Geisler N, Zavrel M

Bioverfahrenstechnik (Vorlesung) (Vorlesung, 2 SWS)
Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

WZS0014: Basics Plant Growing | Grundlagen Pflanzenproduktion

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**Language:** German	**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 exam of the module shall be done in the course of an exam in which the students are to describe different basics of plant growing. By means of questions and tasks comprehension of contexts and interactions between different spheres of action of cultivation systems (e.g. location and production processes) shall be tested. The students explain active principles and objectives of alternative cultivation methods and interpret them for practical application. Type of exam: In writing, Exam duration: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The module aims at imparting to students basic knowledge of cultivation of plant biomass for the use of renewable resources. For that purpose agricultural location as a decisive production factor, integration of cultivation of the respective crops into a cultivation system (farm, types of farms to crop rotations) to the individual process steps of plant production (sowing, fertilisation, crop protection etc.) shall be treated.

Intended Learning Outcomes:
After having participated in the module units the students are able to describe basics of agronomy and plant production.
- The students are able to classify different production prerequisites (location, types of farms etc.) as basics for the cultivation of renewable resources,
The students are able to mention basic production measures and processes of plant production (soil tillage, fertilisation etc.),

- They have understood the significance and functions of different production measures, are able to describe why the measures are required and which impacts shall be pursued and
- the students are able to distinguish alternative methods and procedures within production measures and discuss their pros and cons (e.g. conventional vs. preservative soil tillage).

Teaching and Learning Methods:
The module shall be essentially performed in the teaching format of a lecture. For selected thematic blocks the latter shall be completed by individual and group projects within the scope of which the students are able to independently treat and present well outlined contents. In order to improve learning success repetitions shall be integral part of the module. These are performed by the students in form of short presentations.
For the treated thematic blocks questions of repetition shall be provided in Moodle by means of which the students are able to verify their knowledge independently.

Media:
Lecture, presentations (individual and group projects)

Reading List:
Lütke-Entrup, 2006: Lehrbuch des Pflanzenbaus (Textbook of Plant Production, volume 2: Kulturpflanzen Crops), published by Th. Mann Gelsenkirchen.
Diepenbrock, Ellmauer, Leon, 2009 : Ackerbau, Pflanzenbau und Pflanzenzüchtung (Agriculture, Plant Production and Plant Cultivation). Ulmer Verlag.
Diepenbrock 2014: Nachwachsende Rohstoffe (Renewable Resources), UTB Ulmer (Stuttgart)
Kaltschmitt et al. 2009: Energie aus Biomasse (Energy from Biomass), Springer, Heidelberg
Diepenbrock, Ellmer, Léonvon 2009: Ackerbau, Pflanzenbau und Pflanzenzüchtung (Agriculture, Plant Production and Plant Cultivation) Grundwissen Bachelor (Bachelor's Basic Knowledge). UTB Ulmer (Stuttgart).
Baumer, : Allgemeiner Pflanzenbau (General Plant Production) UTB Uni-Taschenbücher (Stuttgart).

Responsible for Module:
Norman Siebrecht (norman.siebrecht@tum.de)

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

Module Description

WZS0015: Electrical Engineering | Elektrische Energietechnik

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**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:
Exam achievement shall be done in the form of a written test (90 minutes). The students show that they are able to solve computational tasks relating to ac/dc circuits without tools. In addition the students show their understanding of the principles of energy conversion in electrical energy technology by answering questions on case studies.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Modules Physics and Mathematics

Content:
Introduction into electrical energy technology, basics of electrical engineering, especially:
- Charge, electric field
- Amperage, voltage, resistance
- Magnetic field, induction
- Power, electrical energy
- Circuits, Kirchhoff's laws
- Semiconductors
- Transformers, voltage levels
- Electromechanical energy conversion

simple application)s of electrical energy technology (Introduction into power plant technology

Intended Learning Outcomes:
After having participated in the module units the participants are aware of basics of electrical engineering and their associated physical laws. The students are able to use basic equations of electrical engineering to perform simple calculations relating to electrical engineering and energy

technology. Furthermore the students are aware of different possibilities of energy conversion within the scope of electrical energy technology.

Teaching and Learning Methods:
The module consists of one lecture and an associated session of exercises. Contents of the lecture shall be imparted in a speech and deepened through independent preparation of exercises by the students. The finished exercises shall be discussed in the associated session of exercises.

Media:
Presentations, slide scripts, writing on the board

Reading List:
Fischer, R.; Linse, H. (2012): Elektrotechnik für Maschinenbauer, 14. Auflage, ISBN: 978-3-8348-1374-9;
Klaus Heuck, Elektrische Energieversorgung, 2010, Vieweg Teubner;
Panos Konstantin, Praxisbuch Energiewirtschaft, 2009, Springer;
Horst Czichos (Hrsg.), Hütte - Das Ingenieurwissen, 2008, Springer;
Richard Zahoransky (Hrsg.), Energietechnik, 2013, Springer Vieweg

Responsible for Module:
Josef Kainz

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

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

Module Description

WZS0017: Basics Renewables Utilization | Grundlagen der stofflichen Biomassenutzung

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**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:
Assessment takes a written examination (60 minutes), with students recall structure, transformation and use of different renewable resources. Students are required to answer questions using individual formulations and outline structures and reactions. In addition, sample calculations are to be worked out.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Introduction to various kinds of constituents of renewable resources: sugars, polysaccharides, fatty acids and oils, amino acids, proteins, terpenes, aromatics. Their structure, composition, distribution, characteristics, analytics and kind of added value, as well as their use will be introduced.

Intended Learning Outcomes:
After completion of the module units, students understand the chemical composition of renewable resources as well as their production and application. Using this knowledge students are able to explain the respective advantages and disadvantages from the use of renewable resources as well as analyze the underlying physical, chemical and biotechnological principles of their conversion into valuable products.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations and case studies. Corresponding to the teaching content exercise sheets are prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentation, script, blackboard (examples and solutions)

Reading List:
Script, sample solutions for exercises

Responsible for Module:
Broder Rühmann

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung Einführung in die stoffliche Biomassenutzung (2 SWS)
Übungen zur Vorlesung Einführung in die stoffliche Biomassenutzung (2 SWS)
Broder Rühmann, Doris Schieder, Herbert Riepl
For further information in this module, please click campus.tum.de or here.

Module Description

WZS0020: Introduction to Environmental and Resource Economics | Introduction to Environmental and Resource Economics

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**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 examination will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. Type of examination: written, no additional tools allowed

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Microeconomics, macroeconomics

Content:
Environmental and natural resource economics is a rapidly growing and changing field as many environmental issues have become globally important. This course provides concepts such as sustainability (strong and weak) and economic growth, pollution as externality, policy measures for integrating negative external effects (cap and trade, subsidies, taxes, quotas), as well as methods for assessing the monetary value environmental goods and ecosystem services.

Intended Learning Outcomes:
After participation students unterstand the role of the environment and natural resources in theory and practice of economics. Students are aware of the ways in which political decisions about the environment are made and why they often conflict with policy recommendations made by economists. It will make use of microeconomic analysis and will incorporate national and international examples. Students will be able to understand reasons and nature of market failure, related externalities, benefit-cost analysis, market and nonmarket valuation techniques, and cost-effective policy instruments.

Teaching and Learning Methods:
The lecture as well as the tutorial take place by means of powerpoint. In Addition articles from newspapers and scientific journals will be integrated into the lectures. Based on the provided references, students will discuss concepts and derive hypotheses individually and/or groupwise from different perspectives of the current literature. For selected topics, classroom experiments will add up to this. Online lectures from international renowned experts and researchers will be integrated in the lecture.

Media:
Presentations, slide scripts, Articles, online lecture examples

Reading List:
Pearce, D. and R.K. Turner(1990). Economics of Natural Resources and the Environment. Johns Hopkins Univ Pr.
Tietenberg, T. and L. Lewis (2008). Environmental & Natural Resource Economics. Addison Wesley; 8 edition.

Responsible for Module:
Anja Faße

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung Introduction to Environmental and Resource Economics (2 SWS)
Tutorium Introduction to Environmental and Resource Economics (2 SWS)
Anja Faße
For further information in this module, please click campus.tum.de or here.

Module Description

WZS0021: Introduction to Development Economics | Introduction to Development Economics

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**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 will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the development economic. Important international examples will be explained. Type of examination: written, no additional tools allowed

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Microeconomics, macroeconomics

Content:
What is development? What does poverty, inequality and equity mean? What are the determinants of poverty at micro level? What is the role of demography, institutions, labour, property rights, access to capital or microfinancing in developing countries? Which role do natural resources and agriculture play in development? These are some of the questions that decision-makers in the developed and developing countries have to discuss every day. This course provides a theoretical foundation and empirical evidence for the analysis of the most important questions of today's development of the world.

Intended Learning Outcomes:
After studying the module, the students can use the development economy to understand what is hindering development and what factors lead the development to success. They can apply basic theories, concepts, and analytical techniques associated with microeconomics. Students understand the difference between growth and development, measurement of inequality, the importance of agriculture and natural resources in developing countries. The students are able to

analyze empirical evidence on economic development and to critically read the literature in the field of economic development.

Teaching and Learning Methods:
The lecture and tutorial take place by means of powerpoint. In Addition articles from newspapers and scientific journals will be integrated into the lectures. Based on the provided references, students will discuss concepts and derived hypotheses individually and/or groupwise from different perspectives. Online lectures from international renowned experts and researchers will be integrated in the lecture.

Media:
Presentations, slide scripts, Articles, online lecture examples

Reading List:
Alain de Janvry, Elisabeth Sadoulet (2016). Development Economics - Theory and Practice. Routledge; Michael Todaro, Stephen Smith (2012). Economic Development, Pearson.

Responsible for Module:
Anja Faße (anja.fasse@hswt.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Development Economics (Lecture) (Vorlesung, 2 SWS)
Faße A [L], Faße A

Introduction to Development Economics (Tutorial) (Übung, 2 SWS)
Faße A [L], Faße A, Shayo G
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0281: Process Engineering | Verfahrenstechnik

Version of module description: Gültig ab summerterm 2012

Module Level: Bachelor	**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:
written exam

Repeat Examination:

(Recommended) Prerequisites:
This module is in principle suited for all students following a natural scientific or a technical degree program. Basic knowledge in the fields of mathematics, chemistry and biology will be helpful for a better understanding of the contents of this course.

Content:
Process engineering plays an essential role in the development of sustainable solutions. A great variety of materials can be obtained by utilizing chemical, physical or biological processes conducted in specially designed process units and apparatuses.
The module contents are subdivided into mechanical, biological, chemical and thermal processes. The part of the module about mechanical processes addresses the basic unit operations, which are illustrated by examples of high practical relevance. Within biological processes the microbiological basics are described along with different process control strategies and equations for mass balances. While discussing chemical processes, various methods such as thermal, catalytic, electro-, photo- and polychemical techniques are covered. Furthermore, model reactions for different reactor types are deduced. Thermal processes focus on the separation of substrate mixtures.
Another part of the course will be dedicated to plant operation design. Along with flow charts and process relevant equipment, the basics of dimensioning piping as well as the different phases of project management are covered.

Intended Learning Outcomes:
In this module the fundamentals of process engineering for designing and constructing production plants are provided. After completing this module the students will be able to understand the process engineering fundamentals of production facilities and to apply basic engineering and dimensioning methods. Additionally, the students will be capable of analyzing simple processing units and of applying the findings to other production processes and units.

Teaching and Learning Methods:
The module consists of a lecture and an exercise course. The contents of the lecture will be covered through presentations. The students are encouraged to study independently and do literature research. Exercises will be used to improve and deepen the understanding of the lecture contents.

Media:
presentations, blackboard

Reading List:
lecture notes
K. Sattler: Verfahrenstechnische Anlagen. VCH Verlag, Weinheim, 2000
D. Christen: Praxiswissen der chemischen Verfahrenstechnik. Springer, 2009
R. Perry: Chemical Engineers' Handbook. Mcgraw-Hill Professional, 2007

Responsible for Module:
Martin Faulstich (martin.faulstich@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

WZ1002: Master Colloquium | Masterkolloquium

Version of module description: Gültig ab winterterm 2010/11

Module Level:	Language:	Duration:	Frequency:
Credits:* 2	**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

WZ1020: Renewable Resources and Nature Protection | NAWARO und Naturschutz

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
Assessment is based on an oral examination (20 minutes) on nature conservation in relation to renewable resources in order to show, that students are aware of the effects of renewable resources on nature conservation efforts.On a written seminar paper and its presentation students can show, that they are able to roughly evaluate the compatibility of cultivation systems as well as processing of renewable resources with nature conservation. Both oral examination and the presentation are worth 50 % each.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of elective subjects Renewable resources and Agroecosystems.

Content:
Compatibility of production and processing of renewable resources with nature conservation: nature conservation and ecological sustainability; guidelines of ecological sustainability, normative and ethical basics of ecological sustainability; determination and difficulties in estimation of risks; operationalization of ecosystem performance through ecosystem-based approach; special aspects of protected goods, such as soil, water, climate/air, species and biotope; effects of production and processing of renewable resources on environment, nature and landscape; options for optimizing ecological sustainability of renewable resources; special topics such as biodigradable waste/ landscape maintenance material as renewable resource.

Intended Learning Outcomes:
After their participation, students are aware of the effects of renewable resources on nature conservation efforts and are able to roughly evaluate the compatibility of cultivation systems as well

as processing of renewable resources with nature conservation. They will have the knowledge to understand and analyze reviews and academic work on the issue. The module provides the basis for extension of the students' knowledge in a master thesis followed by expert research on the develpment of ecologically reasonable and sustainable cultivation and processing technologies.

Teaching and Learning Methods:
Lectures will bei given, and students independently work on a seminar paper including its presentation.

Media:
Presentations

Reading List:
Sachverständigenrat für Umweltfragen (SRU) (2007): Klimaschutz durch Biomasse. Berlin, Erich Schmidt. Deutscher Rat für Landespflege (DRL) (Hrsg.) (2006): Die Auswirkungen erneuerbarer Energien auf Natur und Landschaft. Bonn, DRL.

Responsible for Module:
Wolfgang Zehlius-Eckert zehlius@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung
NAWARO und Naturschutz
2 SWS
Wolfgang Zehlius-Eckert, Harald Albrecht, Norman Siebrecht, Sebastian Wolfrum

Übung
NAWARO und Naturschutz
1 SWS
Wolfgang Zehlius-Eckert, Harald Albrecht, Norman Siebrecht, Sebastian Wolfrum

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

Module Description

WZ1100: Advanced Environmental and Resource Economics | Advanced Environmental and Resource Economics

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:
The examination will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Mikroökonomie, Makroökonomie

Content:
The field of environmental and natural resource economics is rapidly growing, as many environmental issues have become of a global importance. This course provides concepts for the optimal use of renewable and non-renewable resources. The economics of water, energy markets, as well as natural resources such as fish and forestry are deepened. The theoriy of the New Institutional Economics illustrate the problem of the tragedy of the commons. Macroeconomic concepts such as "Pollution Haven" and the "Environmental Kuznets curve" illustrate the effect of environment on development and trade.

Intended Learning Outcomes:
After visiting the module, the students have an understanding of the role of renewable and non-renewable resources in the economy. Students can differentiate between the maximum economic and sustainable yield. They have an understanding of the functioning of energy and water markets. The students gain an understanding of the New Institutional Economics, in particular the property rights of land and the sustainable use of the global commons. In addition, the students

understand the influence of the environment on the economic development of a country as well as on international trade.

Teaching and Learning Methods:
The lecture and the tutorial take place by means of powerpoint. In Addition articles from newspapers and scientific journals will be integrated into the lectures. Based on the provided references, students will discuss concepts and derive hypotheses individually and/or groupwise from different perspectives of the current literature. For selected topics, classroom experiments will add up to this. Online lectures from international renowned experts and researchers will be integrated in the lecture.

Media:
Presentations, slide scripts, Articles, online lecture examples

Reading List:
Pearce, D. and R.K. Turner(1990). Economics of Natural Resources and the Environment. Johns Hopkins Univ Pr.
Tietenberg, T. and L. Lewis (2008). Environmental & Natural Resource Economics. Addison Wesley; 8 edition.

Responsible for Module:
Anja Faße

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

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

Module Description

WZ1101: Introduction to Renewables Utilization | Einführung in die stoffliche Nutzung

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:
Assessment takes a written examination (60 minutes), with students recall structure, transformation and use of different renewable resources. Students are required to answer questions using individual formulations and outline structures and reactions. In addition, sample calculations are to be worked out.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Attending the module "Chemistry Basics"

Content:
Introduction to various kinds of constituents of renewable resources: sugars, polysaccharides, fatty acids and oils, amino acids, proteins, terpenes, aromatics. Their structure, composition, distribution, characteristics, analytics and kind of added value, as well as their use will be introduced.

Intended Learning Outcomes:
After completion of the modules, students understand the chemical composition of renewable resources as well as their production and application. Using this knowledge students are able to explain the respective advantages and disadvantages as well as analyze the underlying physical, chemical and biotechnological principles of their conversion into valuable products.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations and case studies. Corresponding to the teaching content exercise sheets are

prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentation, script, examples and solutions

Reading List:
script, sample solutions for exercises

Responsible for Module:
Volker Sieber sieber@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Renewables Utilization (Exercise) (Übung, 2 SWS)
Rühmann B

Renewables Utilization (Lecture) (Vorlesung, 2 SWS)
Sieber V [L], Rühmann B, Sieber V
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1103: Introduction to Economics of Renewable Resources | Einführung in die Ökonomie Nachwachsender Rohstoffe

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 schriftlichen Klausur (120 Minuten) erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit und ohne Hilfsmittel ökonomische Zusammenhänge bei der Verwendung Nachwachsender Rohstoffe verstanden worden sind und im Zusammenhang mit einzelbetrieblichen Maßnahmen analysiert und weiterentwickelt werden können. Auch wird mittels der Klausur überprüft, inwieweit die Studierenden die verschiedenen Märkte nachwachsender Rohstoffe charakterisieren und mögliche Lösungswege für die stoffliche und energetische Nutzung aufzeigen können.
Der Teilbereich "Ökonomie Nachwachsender Rohstoffe" geht mit 65 % und der Teilbereich "Märkte Nachwachsender Rohstoffe" mit 35 % in die Gesamtnote ein.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Die Vorlesung gliedert sich in 3 Teilbereiche auf. Diese sind inhaltlich weitgehend voneinander unabhängig, thematisieren aber verschiedene Facetten der Ökonomie von Nachwachsenden Rohstoffen.
1. Vorlesung Ökonomie Nachwachsender Rohstoffe
Einführung in die Grundlagen der Ökonomie anhand ausgewählter Konversionspfade auf der Basis Nachwachsender Rohstoffe von Standortentscheidungen über die Beschaffung und Logistik, Produktion, zwischenbetrieblichen Verbindungen bis zur externen Berichterstattung
2. Übung zur Ökonomie Nachwachsender Rohstoffe

Die fachlichen Inhalte der Vorlesung werden anhand von Fallbeispielen analysiert und kritisch bewertet, so dass die Teilnehmer die Inhalte in ihrer späteren beruflichen Tätigkeit eigenständig weiterentwickeln können.
3. Vorlesung Märkte Nachwachsender Rohstoffe
Darstellung verschiedener Märkte der Nachwachsenden Rohstoffe. Diese sind aufgeteilt in die stoffliche Nutzung (Bioschmierstoffe, Werkstoffe, chemische Grundstoffe und Feinchemikalien) und in die energetische Nutzung (Wärme, Elektrizität und Mobilität)

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung können die Studierenden die ökonomischen Grundlagen der Verwendung Nachwachsender Rohstoffe differenziert anwenden und die Wirtschaftlichkeit anhand von einzelbetrieblichen Fallbeispielen analysieren und bewerten. Des Weiteren sind sie in der Lage, die betriebs- und marktwirtschaftlichen Zusammenhänge bei der Verwertung Nachwachsender Rohstoffe kritisch zu beurteilen und aktuelle Entwicklungen dabei einzubeziehen. Darüber hinaus können die Studierenden die verschiedenen Vermarktungsformen und Marktgrößen von Nachwachsenden Rohstoffen einschätzen und vergleichend kombinieren.

Teaching and Learning Methods:
Vorlesung; Diskussionen; Fallbeispiele
Mit Hilfe der Vorlesungen und der Übung werden alle Teilbereiche des Moduls vorgestellt. Mit Hilfe dieser Methode kann das umfangreiche Stoffvolumen am besten vermittelt werden. In den Diskussionen lernen die Studierenden, unterschiedliche Perspektiven zu integrieren und die Modulinhalte richtig einzuordnen und kritisch zu beurteilen.

Media:
Präsentationen, Skript, Fallbeispiele

Reading List:
Wacker, H., Blank, J. E.: Ressourcenökonomie, Bd. 1 und 2 Einführung in die Ressourcenökonomie, München, Oldenbourg Verlag, 1999.; KALTSCHMITT, M. und H. HARTMANN (Hrsg.): Energie aus Biomasse. Grundlagen, Techniken und Verfahren. Springer Berlin, 2009; Vahs, D., Schäfer-Kunz, J.: Einführung in die Betriebswirtschaftslehre. Schäffer-Poeschel Verlag Stuttgart. 2012

Responsible for Module:
Prof. Hubert Röder

Courses (Type of course, Weekly hours per semester), Instructor:
Overview Markets of Renewable Resources (Lecture) (Vorlesung, 1,5 SWS)
Decker T

Management of Renewable Resources (Exercise) (Übung, 1 SWS)
Röder H

Management of Renewable Resources (Lecture) (Vorlesung, 1,5 SWS)
Röder H [L], Pokholkova M, Röder H
For further information in this module, please click campus.tum.de or here.

Reading List:
Charles E. Mortimer, Ulrich Müller, Chemie, 10., überarbeite Auflage, Thieme Verlag, Stuttgart, 2010. script, sample solution exercises

Responsible for Module:
Doris Schieder (doris.schieder@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Allgemeine und anorganische Chemie / Angleichung Chemie (Vorlesung) (Vorlesung, 2 SWS)
Riepl H [L], Riepl H

Allgemeine und anorganische Chemie (Übung) (Übung, 2 SWS)
Riepl H [L], Riepl H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1106: Chemistry Basics | Grundlagen Chemie

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** German	**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:
Assessment takes the form of a written examination (60 minutes). Students will demonstrate their knowledge of taught basic principles and reaction mechanisms in chemistry, as well as their ability to apply their knowledge to new tasks. Answering questions in part requires indivudual expression and drawing of structures as well as description of reaction equations. In addition, sample calculations are to be worked out.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in mathematics, physics, chemistry, equivalent to basic courses of German highschools

Content:
General basics in Chemistry: Structure of atoms and molecules; structure, nomenclature and characteristics of compounds; special aspects of thermodynamics; reaction kinetics and chemical catalytics; redox reactions; acids and bases, selected reaction mechanisms of organic chemistry

Intended Learning Outcomes:
Students are aware of the principles and basic reaction mechanisms in chemistry and they are able to apply them to new tasks. Their acquired knowledge enables them to participate in further courses that require basic knowledge of chemistry, especially "Introduction to materials use".

Teaching and Learning Methods:
Lecture: talks by lecturers; associated tutorials with individual work on case examples

Media:
Presentation, blackboard, exercise sheets

Reading List:
Charles E. Mortimer, Ulrich Müller, Chemie, 10., überarbeite Auflage, Thieme Verlag, Stuttgart, 2010. Skript, Musterlösung Übungen

Responsible for Module:
Doris Schieder (doris.schieder@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Allgemeine und anorganische Chemie / Angleichung Chemie (Vorlesung) (Vorlesung, 2 SWS)
Riepl H [L], Riepl H

Allgemeine und anorganische Chemie (Übung) (Übung, 2 SWS)
Riepl H [L], Riepl H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1108: Equalization Economics | Angleichung Ökonomie

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	Language: German	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:
Assessment takes the form of a written examination (90 minutes). Participants demonstrate their basic understanding and ability to explain basics of business administration and micro-/macroeconomy.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Lecture part 1: Introduction to Business Administration

The "Business Administration" unit introduces fundamental concepts of various business administration areas thereby providing terminology and basic understanding of the topic which is important for working life and participation in further modules.
1. Introduction: the company as the subject-matter of Business Administration, business typology, business objectives.
2. Organisation & Management: Organisational structures and theoretical approaches, management function, strategic management, corporate culture and corporate ethics
3. Finance: basic financial concepts, financial planning and monitoring, types of financing, optimization of company financing
4. Investment: Investment appraisal, corporate valuation.
5. Staff: staff procurement, staff deployment, motivation, staff development
6. Production and Materials Management: procurement and inventory planning, procurement marketing, production planning and control, production and cost theory
7. Accounting: external accounting under HGB and IFRS, internal accounting

8. Marketing: market research, product policy, distribution policy, terms and conditions, communications strategy

Lecture part 2: Introduction to Economics
In the "Economics" unit, insights and theories from Microeconomics are introduced on the bais of case studies from the renewable resources sector. The significance of political developments for company practice in the renewable resources sector is outlined.
1. Fundamental concepts
2. The market forces of supply and demand
3. Consumer theory, business theory
4. Consumer and producer surplus
5. Elasticity and its applications
6. Externalities, public goods and societal resources
7. Economic policy measures, taxation

Intended Learning Outcomes:
At the end of the module students understand and are able to explain the interrelations of various areas of Business Administration and Economics. They are in particular capable of applying their knowledge about economic concepts on issues relevant to the renewable resources sector.

Teaching and Learning Methods:
The contents of the module are presented in lectures with case studies included for additional information.

Media:
Presentations, lecture notes, work sheets

Reading List:
1. LV: Introduction in business administration
Einführung in die Betriebswirtschaftslehre, Vahs/Schäfer-Kunz, Schäffer-Poeschel, 6. Auflage;
Einführung in die Allgemeine Betriebswirtschaftslehre, Wöhe/Döring, Vahlen, 24. Auflage;
Grundzüge der Betriebswirtschaftslehre, Schierenbeck, Oldenbourg Wissenschaftsverlag, 18. Auflage;

2. LV: Introduction in business administration
Grundzüge der Volkswirtschaftslehre, Mankiw, Schäffer-Poeschel, 4. Auflage; Environmental Economics for Tree Huggers and other Skeptics, Jaeger, Island Press, 1.Auflage;

Responsible for Module:
Hubert Röder (hubert.roeder@hswt.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung
Einführung in die Betriebswirtschaft

1 SWS
Vorlesung
Einführung in die Volkswirtschaft
1 SWS
Hubert Röder
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1108: Basics of Economics | Grundlagen der Ökonomie

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** German	**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:
Assessment takes the form of a written examination (90 minutes). Participants demonstrate their basic understanding and ability to explain basics of business administration and micro-/ macroeconomy.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Lecture part 1: Introduction to Business Administration

The "Business Administration" unit introduces fundamental concepts of various business administration areas thereby providing terminology and basic understanding of the topic which is important for working life and participation in further modules.
1. Introduction: the company as the subject-matter of Business Administration, business typology, business objectives.
2. Organisation & Management: Organisational structures and theoretical approaches, management function, strategic management, corporate culture and corporate ethics
3. Finance: basic financial concepts, financial planning and monitoring, types of financing, optimization of company financing
4. Investment: Investment appraisal, corporate valuation.
5. Staff: staff procurement, staff deployment, motivation, staff development
6. Production and Materials Management: procurement and inventory planning, procurement marketing, production planning and control, production and cost theory
7. Accounting: external accounting under HGB and IFRS, internal accounting

8. Marketing: market research, product policy, distribution policy, terms and conditions, communications strategy

Lecture part 2: Introduction to Economics
In the "Economics" unit, insights and theories from Microeconomics are introduced on the bais of case studies from the renewable resources sector. The significance of political developments for company practice in the renewable resources sector is outlined.
1. Fundamental concepts
2. The market forces of supply and demand
3. Consumer theory, business theory
4. Consumer and producer surplus
5. Elasticity and its applications
6. Externalities, public goods and societal resources
7. Economic policy measures, taxation

Intended Learning Outcomes:
At the end of the module students understand and are able to explain the interrelations of various areas of Business Administration and Economics. They are in particular capable of applying their knowledge about economic concepts on issues relevant to the renewable resources sector.

Teaching and Learning Methods:
The contents of the module are presented in lectures with case studies included for additional information.

Media:
Presentations, lecture notes, work sheets

Reading List:
1. LV: Introduction in business administration
Einführung in die Betriebswirtschaftslehre, Vahs/Schäfer-Kunz, Schäffer-Poeschel, 6. Auflage; Einführung in die Allgemeine Betriebswirtschaftslehre, Wöhe/Döring, Vahlen, 24. Auflage; Grundzüge der Betriebswirtschaftslehre, Schierenbeck, Oldenbourg Wissenschaftsverlag, 18. Auflage;

2. LV: Introduction in business administration
Grundzüge der Volkswirtschaftslehre, Mankiw, Schäffer-Poeschel, 4. Auflage; Environmental Economics for Tree Huggers and other Skeptics, Jaeger, Island Press, 1.Auflage;

Responsible for Module:
Hubert Röder (h.roeder@wz-straubing.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

WZ1109: Equalization Engineering | Angleichung Ingenieurwissen

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
Students demonstrate their understanding and ability to reproduce engineering basics in a written examination (90 minutes). This includes topics such as heat engineering or fluid mechanics as well as respective technical procedures. Further questions in the examination relate to the topics of safety at work and explosion control.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics in physics and chemistry.

Content:
This module teaches essential basics of engineering. Topics such as heat engineering, fluid mechanics and technical procedures are addressed, as well as safety at work and explosion control.

Intended Learning Outcomes:
At the end of the module students understand basic terminology, methods, machines and components of processing techniques relevant to the field of renewable resources. The module unit enables participants to solve tasks independently and to determine problem-solving strategies from the fields mentioned above. Students understand basic component design and are therefore able to enter into dialogue with experts from different areas of process engineering.

Teaching and Learning Methods:
Seminar lectures, tutorials, external lectures

Media:
Presentations (handout)

Reading List:
Physik- und Mathematikformelsammlungen
Hemming et al. (2011): Verfahrenstechnik. Würzburg: Vogel

Responsible for Module:
Matthias Gaderer (gaderer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung:
Angleichung Ingenieurwissen: 1 SWS
Übung:
Angleichung Ingenieurwissen: 1 SWS
Wolfgang Waldmüller
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1109: Fundamentals of Engineering | Grundlagen Ingenieurwissen

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
Students demonstrate their understanding and ability to reproduce engineering basics in a written examination (90 minutes). This includes topics such as heat engineering or fluid mechanics as well as respective technical procedures. Further questions in the examination relate to the topics of safety at work and explosion control.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics in physics and chemistry

Content:
This module teaches essential basics of engineering. Topics such as heat engineering, fluid mechanics and technical procedures are addressed, as well as safety at work and explosion control.

Intended Learning Outcomes:
At the end of the module students understand basic terminology, methods, machines and components of processing techniques relevant to the field of renewable resources. The module unit enables participants to solve tasks independently and to determine problem-solving strategies from the fields mentioned above. Students understand basic component design and are therefore able to enter into dialogue with experts from different areas of process engineering.

Teaching and Learning Methods:
Seminar lectures, tutorials, external lectures

Media:
Presentations (handout)

Reading List:
Physik- und Mathematikformelsammlungen
Hemming et al. (2011): Verfahrenstechnik. Würzburg: Vogel

Responsible for Module:
Matthias Gaderer (gaderer@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

WZ1110: Equalization Biology | Angleichung Biologie

Version of module description: Gültig ab winterterm 2015/16

Module Level: 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:
Assessment will be in the form of a written examination (60 minutes) with students reflect their basic knowledge of Biology of renewable resources. The examination includes cloze tests, formulation of answers and multiple choice tests.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of chemistry is recommended.

Content:
Renewable resources: general aspects of biology
-Evolution/hierarchy of life, water, biomolecules, nucleic acids, central dogma, molecular biology of prokaryotes and eukaryotes
-cultures, artificial and natural classification, polyphase approach, polymerase chain reaction and fluorescence in-situ hybridization (methods)
-cell dimensions, light/fluorescence microscopy (methods), electron microscopy
-basic principles of catabolism and anabolism, general metabolic pathways and strategies for energy production
-viroids, bacteriophages, virus: general characteristics, structure, classification, plant virus (phytopathology, phytomedicine)
-prokaryotes: general characteristics, structure, classification, osmosis, transport, phytopathology, phytomedicine, nitrogen fixation, white biotechnology
-chitinous fungi: general characteristics, structure, classification, functions, phytopathology, phytomedicine, mycorrhiza
-plant cells: general characteristics, structure, cell organells, transport, metabolism, photosynthesis, C3-C4- plants

- excursion to BTA-school

Intended Learning Outcomes:
After completion of this module, which leads in a stringent way from macromolecules to highly developed forms of life, students will understand crucial relationships in biology. Using this knowledge they are able to put closely related lectures into contextual relation to biology and gain a broad and profound understanding of the subject. During an excursion of several hours which leads students to a laboratory at the BTA-School, they will be shown a fluorescence microscope to deepen their knowledge in a real-life setting.

Teaching and Learning Methods:
Lecture:Talks given by lecturers, exercises and supervised laboratory experiment

Media:
Blackboard, PowerPoint, demonstration material

Reading List:
Sadava, D., Hills, D., Heller, C.H., Berenbaum, M.R.: Purves Biologie. Spektrum akademischer Verlag, 9. Auflage 2012. Mortimer, Ch., E., Müller, U.. Chemie. Thieme-Verlag Stuttgart, 10. Auflage 2010.

Responsible for Module:
Robert Huber (ga72hih@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen Biologie (Vorlesung) / Angleichung Biologie (Vorlesung, 2 SWS)
Glawischnig E [L], Glawischnig E
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1110: Basic Biology | Grundlagen der Biologie

Version of module description: Gültig ab winterterm 2015/16

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

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

Description of Examination Method:
Assessment will be in the form of a written examination (60 minutes) with students reflect their basic knowledge of Biology of renewable resources. The examination includes cloze tests, formulation of answers and multiple choice tests.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of chemistry is recommended.

Content:
Renewable resources: general aspects of biology
-Evolution/hierarchy of life, water, biomolecules, nucleic acids, central dogma, molecular biology of prokaryotes and eukaryotes
-cultures, artificial and natural classification, polyphase approach, polymerase chain reaction and fluorescence in-situ hybridization (methods)
-cell dimensions, light/fluorescence microscopy (methods), electron microscopy
-basic principles of catabolism and anabolism, general metabolic pathways and strategies for energy production
-viroids, bacteriophages, virus: general characteristics, structure, classification, plant virus (phytopathology, phytomedicine)
-prokaryotes: general characteristics, structure, classification, osmosis, transport, phytopathology, phytomedicine, nitrogen fixation, white biotechnology
-chitinous fungi: general characteristics, structure, classification, functions, phytopathology, phytomedicine, mycorrhiza
-plant cells: general characteristics, structure, cell organells, transport, metabolism, photosynthesis, C3-C4- plants

- excursion to BTA-school

Intended Learning Outcomes:
After completion of this module, which leads in a stringent way from macromolecules to highly developed forms of life, students will understand crucial relationships in biology. Using this knowledge they are able to put closely related lectures into contextual relation to biology and gain a broad and profound understanding of the subject. During an excursion of several hours which leads students to a laboratory at the BTA-School, they will be shown a fluorescence microscope to deepen their knowledge in a real-life setting.

Teaching and Learning Methods:
Lecture:Talks given by lecturers, exercises and supervised laboratory experiment

Media:
Blackboard, PowerPoint, demonstration material

Reading List:
Sadava, D., Hills, D., Heller, C.H., Berenbaum, M.R.: Purves Biologie. Spektrum akademischer Verlag, 9. Auflage 2012. Mortimer, Ch., E., Müller, U.. Chemie. Thieme-Verlag Stuttgart, 10. Auflage 2010.

Responsible for Module:
Robert Huber (ga72hih@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

WZ1112: Plant Biotechnology and Plant Breeding | Pflanzenbiotechnologie und Pflanzenzüchtung

Version of module description: Gültig ab summerterm 2013

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:
In a written examination (90 minutes), students have to demonstrate their knowledge and ability to reproduce basics of plant breeding and related biotechnological methods.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of biotechnological procedures and applications

Content:
Lectures: Talks mainly focus on biotechnological methods used in plant breeding. Methods for the develpment of new varieties and phytoremediation will bei introduced. Main focus is set on cell culture, procedures of molecular analysis and gene technologies as well as possibilities and limitations of those methods.
Special series of lectures: Guest speakers from the field of plant breeding present examples and provide insight into their practical work.
Excursion: Guided visit of a plant breeding company. Students will be shown around the laboratories of molecular technologies and cell culture as well as the greenhouses and cultivation areas.

Intended Learning Outcomes:
In the course students acquire basic knowledge of plant breeding and related biotechnological methods. They develop a basic understanding of procedures leading to new varieties of plants.

Teaching and Learning Methods:
The contents will bei presented in the form of a lecture with guest speakers providing their expertise. The practical application of theoretical issues are demonstrated in an excursion.

Media:
Power Point

Reading List:

Responsible for Module:
Erich Glawischnig (glawischnig@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

WZ1115: Agroforestry Systems | Agroforstsysteme

Version of module description: Gültig ab winterterm 2015/16

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:
Assessment takes a written form (90 minutes). Students show the extent to which they are able to determine practicable and highly economical alley cropping and apply this knowledge to develop solutions to real-life problems. They are also expected to analyze various ecological aspects such as carbon sequestration and erosion protection with the help of introduced examples. Students demonstrate their understanding of the topic when answering questions on crop processing systems.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics in Silviculture WZ1607

Content:
Role and distribution of agroforestry systems in Germany and all over the world. Introduction to special agroforestry systems for production of renewable resources and their importance. Establishment and use of agroforestry systems. Ecological impact of agroforestry systems: interactions between trees and agricultural systems, competitive relationships, carbon sequestration, CO2 avoidance, erosion protection, dynamics of soil moisture, biomass production, economic evaluation and funding options, propagation and harvesting of appropriate plants, potential applications of crops (e.g. in firing systems).

Intended Learning Outcomes:
Students are able to discuss the ecological and economic potential of agroforestry systems for production of renewable resources. They can evaluate the performance of agroforestry systems and apply concepts for agroforestry systems of typical areas (selection of appropriate wood plants and use systems, localisation of forest belts for optimal performance in the ecosystem). Students

can evaluate agroforestry systems and crop use from a basic economical perspective (efficiency analysis, risks, marketing and strategies for their use).

Teaching and Learning Methods:
Lectures introduce basic knowledge; tutorials on identification of appropriate trees and bushes. Excursion to agroforestry systems in active and trial operations, demonstrating possible damages and causes.

Media:
Lectures given as presentations, examples, group work, case studies

Reading List:
Anbau und Nutzung von Bäumen auf landwirtschaftlichen Flächen Gebundene Ausgabe – Wiley-VCH Verlag GmbH & Co. KGaA; Auflage: 1. Auflage 2009
Tatjana Reeg, Albrecht Bemmann, Werner Konold, Dieter Murach, Heinrich Spiecker;
Kurzumtriebsplantagen: Holz vom Acker - So geht's Taschenbuch – DLG-Verlag, 2012
Dirk Landgraf, Frank Setzer;
Aktuelle Veröffentlichen in Fachzeitschriften

Responsible for Module:
Höldrich, Alexander; Dr. agr.

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

Alexander Höldrich (alexander.hoeldrich@tum.de)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1120: Medicinal and Spice Plants | Heil- und Gewürzpflanzen

Version of module description: Gültig ab winterterm 2015/16

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 a written examination (60 minutes), students demonstrate their ability to identify important medicinal and aromatic plants, as well as outline methods of cultivation, harvesting and drying. In addition, they have a limited time frame to classify medical effects and chemical compounds. During the course of the module, students give a detailed presentation on certain medicinal and aromatic plants, which also informs the assessment.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Organic and anorganic chemistry, botany, plant cultivation or Introduction to biology (WZ1110), chemistry (WZ1106), cultivation systems (WZ1107).

Content:
History of medicinal plants, identification of medicinal plants, special aspects of cultivation of aromatic plants, plant protection and harvesting. Drying methods used for herbs. Different classes of active substances, such as terpenes, coumarin, flavonoids and certain effect-determining ingredients. Several extraction and analysis methods of isolation of the active substance, e.g. Soxhlet extraction, thin-layer chromatography or infrared spectroscopy. Frequent mechanisms of action, e.g. inflammation cascade, infections, neurotransmission or digestion system. Current cultivation systems and use of medicinal and aromatic plants.

Intended Learning Outcomes:
After participation in the module, students know how to characterize medicinal and aromatic plants, inclucing basics of cultivation systems in herb gardens and fields. They are aware of different techniques such as drying and harvesting of various medicinal and aromatic plants. Examples are used to demonstrate the students' ability to classify medical effects and chemical compounds.

Participating in tutorials on laboratorial work, students learn how to perform analytical-chemical analyses on medicinal and aromatic plants as well as deducing the respective classes of active substance.

Teaching and Learning Methods:
Lecture (talks given by teaching staff using PowerPoint media, books and other written material), excursion to process engineering company. Tutorials (e.g. students perform supervised experiments)

Media:
PowerPoint presentation and lecture notes.
Laboratory equipment for experiments, exercises about analysis

Reading List:
Deutschmann, F., Hohmann, B., Sprecher, E., Stahl, E., Pharmazeutische Biologie, 3 Bde., G. Fischer Verlag, 1992
Wendelberger, E., Heilpflanzen: Erkennen | Sammeln | Anwenden Broschiert – BLV Buchverlag Januar 2013
Dingermann, Hiller, Schneider, Zündorf 2011, Arzneidrogen Spektrum akademischer Verlag

Responsible for Module:
Alexander Höldrich (alexander.hoeldrich@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

WZ1121: Generation of Electricity from Biomass | Erzeugung von Strom aus Biomasse

Version of module description: Gültig ab winterterm 2012/13

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:
Prüfungsdauer (in min.): 120 Minuten.
schriftliche Prüfung

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreiche Teilnahme an den Modulen "Grundlagen Ingenieurwissen" und "Einführung in die energetische Nutzung" oder vergleichbare ingenieurwissenschaftliche Kenntnisse

Content:
In diesem Modul werden auf Basis thermodynamischer Konversionsprozesse Verfahren zur Stromerzeugung aus biogenen Energieträgern vorgestellt. Neben einem systemischen Überblick zur nationalen und internationalen Stromerzeugung und -versorgung sind die wesentlichen Inhalte dieser Vorlesung rein technischer Art. Weitere Inhalte sind unter anderem verschiedene Kraftwerkstypen (zentral/dezentral), Kraftwerkskomponenten und Komponenten zur Stromerzeugung, entstehende Rückstände und Nebenprodukte sowie Einblicke in die Auslegung von Kraftwerkskomponenten.
In der Übung werden die theoretischen Ausführungen der Vorlesungen anhand von Rechenbeispielen erläutert.
Des Weiteren ist im Rahmen dieser Lehrveranstaltung eine Exkursion vorgesehen.

Intended Learning Outcomes:
Die Studierenden sind nach dem Besuch der Vorlesung in der Lage Techniken zur Erzeugung von Strom aus biogenen Energieträgern zu analysieren. Sie können auf Basis des erworbenen

Wissens Erzeugungsstrategien von Strom bewerten und bedarfsgerechte Konzepte zur Stromerzeugung aus Biomasse entwickeln.

Teaching and Learning Methods:
Vorlesung (Vortrag durch Lehrpersonal mit PP-Medien, Büchern und sonstigem Material), Übung (Selbstständige Ausarbeitung von Übungsaufgaben durch die Studierenden mit anschließenden Erklärungen durch Lehrpersonal, teils Vorrechnen von Aufgaben), Exkursion

Media:
Präsentationen, Folienskripte, Tafelaufschrieb; Exkursion

Reading List:
Cerbe, G., Wilhelms G. (2008): Technische Thermodynamik. München: Hanser Verlag

Responsible for Module:
Martin Faulstich (martin.faulstich@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

WZ1122: Energy Technology I | Energietechnik I

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.): 90 Minuten.
schriftliche Prüfung am Semesterende

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreiche Teilnahme an den Modulen "Grundlagen Ingenieurwissen", "Einführung in die enertetische Nutzung" sowie "Erzeugung von Strom aus Biomasse". Neben Grundkenntnissen über die Funktonsweise verschiedener Kraftwerkstypen sind physikalische Grundlagen der einfachen Elektrotechnik wie Größen, elementare Grundschaltungen im Reihen- und Wechselstromkreis notwendig.

Content:
Der Schwerpunkt der elektrischen Energietechnik vermittelt auf der Basis elektrotechnischer Grundlagen zu Gleich- und Wechselstrom die Funktionsweise und Eigenschaften von elektrischen Energienetzen (Drehstrom und Gleichstromnetze). Neben der ausführlichen Darstellung der eingesetzten Komponenten wie Generatoren und Transformatoren wird insbesondere die Funktionsweise der Systemregelung erläutert. Abschließend wird auf innovative Systemkonzepte wie "Smart Grids" eingegangen.

Intended Learning Outcomes:
Die Vorlesung befähigt die Studierenden die Rolle dieser Kraftwerke im Verbundnetz und die Regelungsmechanismen, welche zur Stabilisierung der Energienetze notwendig sind, zu verstehen. Auch die entstehenden Herausforderungen durch den Ausbau der erneuerbaren Energien sind den Studenten nach dem Besuch der Vorlesung geläufig und können von ihnen bewertet werden. Weiterhin kennen sie die prinzipielle Funktionsweise zukünftiger Konzepte wie

Smart-Grids oder virtueller Kraftwerke. Hier ist den Studenten sowohl der Stand der Technik, als auch der Entwicklunsbedarf bekannt.

Teaching and Learning Methods:
Vorlesung (Vortrag durch Lehrpersonal mit PP-Medien, Büchern und sonstigem schriftlichem Material)

Media:
Präsentationen, Folienskripte

Reading List:
Praxisbuch Energiewirtschaft: Energieumwandlung, -transport und -beschaffung im liberalisierten Markt; Panos Konstantin
Renewable Energy Technology, Economics and Environment; Martin Kaltschmitt
Energy conversion; Yogi Goswami, Frank Kreith

Responsible for Module:
Martin Faulstich (Martin.Faulstich@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

WZ1123: Energy Technology II | Energietechnik II

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 Minuten.
schriftliche Prüfung

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreiche Teilnahme an den Modulen "Einführung in die energetische Nutzung" und "Erzeugung von Strom aus Biomasse". Weiterhin sollen fundierte mathematische, physikalische und thermodynamische Kenntnisse vorhanden sein.

Content:
Der Schwerpunkt der Energiespeicher zeigt unterschiedlichste Speicherkonzepte und Speicherarten für Strom und Wärme auf, beschreibt deren Eigenschaften und charakterisiert diese anhand geeigneter technischer und ökonomischer Kennzahlen. Weiterhin wird der aktuelle Stand der Technik sowie Optimierungsmöglichkeiten aufgezeigt. Im Bereich der Energiewirtschaft wird auf die Nachfrage nach elektrischer Energie sowie einschlägige Prognosemodelle eingegangen. Neben der Vorstellung der Energieversorgungsakteure in Deutschland werden weiterhin die Handesplätze für Energie sowie deren Funktionsweise erklärt. Weiterhin werden die Merkmale des liberalisierten Energiemarktes sowie die energierechtlichen Rahmenbedingungen behandelt.

Intended Learning Outcomes:
Mit dem Besuch der Modulveranstaltung sind die Studierenden in der Lage, die unterschiedlichen Möglichkeiten der Energiespeicherung zu klassifizieren und sie anwendungsrelevant einzuordnen. Die Sudenten sind weiterhin befähigt, praktische Aufgabenstellungen im Hinblick auf technische Realisierbarkeit zu beurteilen. Weiterhin kennen die Studierenden die Beschaffungsmöglichkeiten

von leitungsgebundener Energie, die Vermarktungsmöglichkeiten für elektrische Energie, und unterschiedliche Bezugs- und Lieferverträge.

Teaching and Learning Methods:
Vorlesung (Vortrag durch Lehrpersonal mit PP-Medien, Büchern und sonstigem schriftlichem Material)

Media:
Power-Point-Folien, Tafelaufschrieb, Diskussionen;

Reading List:
Praxisbuch Energiewirtschaft: Energieumwandlung, -transport und -beschaffung im liberalisierten Markt; Panos Konstantin
Renewable Energy Technology, Economics and Environment; Martin Kaltschmitt
Energy conversion; Yogi Goswami, Frank Kreith

Responsible for Module:
Faulstich Martin (Martin.Faulstich@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

WZ1124: Renewable Energy for Transportation | Regenerative Energien im Transportsektor

Version of module description: Gültig ab winterterm 2012/13

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 Minuten.
Die Lernergebnisse werden schriftlich in einer Klausur überprüft.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Pflichtmodul "Einführung in die energetische Nutzung" und geg. Angleichungsmodul "Grundlagen Ingenieurwissen" und "Grundlagen Chemie" oder vergleichbares Vorwissen

Content:
INHALTE VORLESUNGEN UND SEMINAR: Besonderheiten und Anforderungen der Kraftstoffbereitstellung und -nutzung im Transportsektor; Herstellungs- und Nutzungspfade von regenerativen Kraftstoffen, v.a. Biokraftsstoffen, im Vergleich zur fossilen Referenz: Rohstoffe, Konversionstechnologien und motorische Nutzung;
Grundlagen Verbrennungsmotoren und Fahrzeugtechnik; Grundlegendes Wissen über den motorisierten Individualverkehr; Fahrwiderstände, Fahrleistungen und Energiebedarf von Fahrzeugen; Kennenlernen der Funktionsweise von Fahrzeugantrieben wie Verbrennungsmotor, Elektroantrieb, Hybridantrieb, Brennstoffzelle, &
Der Schwerpunkt liegt auf technologischen Aspekten, jedoch werden auch ökonomische und ökologische Gesichtspunkte und rechtliche Rahmenbedingungen einbezogen. Weiterhin wird eine Methodik zur Bewertung der energetischen Effizienz von Kraftstoffbereitstellungsnutzungsketten vermittelt;
INHALTE PRAKTIKUM: Betrieb und Funktionsweise ausgewählter Antriebsysteme; Betrieb von Verbrennungsmotoren mit regenerativen Kraftstoffen

Intended Learning Outcomes:

Nach erfolgreichem Abschluss des Moduls können die Studentinnen und Studenten das Potenzial nachwachsender Rohstoffe zur Energiebereitstellung für den Transportsektor unter technologischen, ökologischen und ökonomischen Gesichtspunkten einschätzen. Weiterhin sind sie in der Lage, Stärken, Schwächen und Entwicklungspotenziale verschiedener Kraftstoffpfade zu erkennen und kritisch zu bewerten. Nach Abschluss des Moduls können die Hörer zudem eine ganzheitliche energetische Bilanzierung von Kraftstoffpfaden mindestens in den Grundlagen durchführen. Antriebstechnologien + Praktikum: Die Studentinnen und Studenten
Rse* haben die [illegible] Berechnung der erforderlichen Fahrwiderstände, Fahrleistungen und des Energiebdarfs erlangt. Sie können die Effizienz von Antriebsystemen analysieren und berechnen. Des V[illegible]

Module Description

WZ1125: Biogas Technology II | Biogastechnologie II

Version of module description: Gültig ab winterterm 2012/13

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.): 20 Minuten.
mündliche Prüfung

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreiche Teilnahme an den Modulen Grundlagen Biologie und Grundlage der energetischen Nutzung. Kenntnisse der Botanik: Zellbiologie, Anatomie, Ökologie, teilweise Stoffwechselphysiologie; Kenntnisse in Mikrobiologie: Stoffwechselphysiologie, teilweise organische Chemie; von Vorteil: landwirtschaftliche Kenntnisse, Agrartechnik

Content:
Im Modul werden biologische und verfahrenstechnische Elemente der Biogastechnologie gelehrt. Dies beinhaltet detailiert die mikrobiologischen Stoffwechselvorgänge beim anaeroben Abbau, insbesondere die einzelnen Einflussfaktoren auf den Gärprozess. Daraus werden Optimierungsstrategien abgeleitet. Zudem werden die Verwertungswege von Biogas, wie die Verbrennung in BHKWs oder die Einspeisung ins Erdgasnetz, dargestellt. Zusätzlich zu den ingenieurwissenschaftlichen Themen werden rechtliche und wirtschaftliche Aspekte, aber auch Kenntnisse bei der Erstellung von Treibhausgasbilanzen im Modul gelehrt.

Intended Learning Outcomes:
Die Studierenden sind nach dem erfolgreichen Besuch des Moduls in der Lage Systeme zur Biogaserzeugung und -verwertung ganzheitlich zu verstehen und zu bewerten. Die Studierenden sind befähigt, den mikrobiellen Stoffwechselprozess in Biogasanlagen zu analysieren und Strategien zur Otpimierung abzuleiten. Die Studierenden werden in der Lage sein, Konzepte im Bereich der Biogastechnologie zu entwickeln.

Teaching and Learning Methods:
Vorlesung mittels Präsentationen; Lehrveranstaltung evtl. ergänzt durch ein Seminar;
Abhalten einer Exkursion zu einer Biogasanlagen mit Methaneinspeisung ins Gasnetz; je nach Forschungsbetrieb Untermauern der Theorie mittels Rundgänge durchs Labor

Media:
Präsentationen, Folienskripte

Reading List:
Bücher: Kaltschmitt, Hartmann (2004): Energie aus Biomasse; Bischofsberger (2005): Anaerobtechnik; Eder, Schulz (2007): Biogas Praxis; KTBL (2010) Faustzahlen Biogas
Journals: Biogas Journal; EnergiePflanzen; Biomass&Bioenergy
Internet: www.fnr.de; www.fachverband-biogas.de; www.biogas-forum-bayern.de; www.carmen-ev.de

Responsible for Module:
Martin Faulstich (martin.faulstich@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

WZ1131: Biomass-Derived Heat (and Power) Stations | Heiz(kraft)werke auf Basis fester Biomasse

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** German	**Duration:** two semesters	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 140	**Self-study Hours:** 100	**Contact Hours:** 40

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

Description of Examination Method:
Assessment includes a written examination (60 minutes) about theoretical knowledge of combined heat and power stations (50% of the final grade). Furthermore, students are assessed on project work about a power station which is presented in a seminar (30 minutes) (50% of the final grade).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Participation in the module "Introduction to energetic use" and "Basics of engineering" is recommended. Technical knowledge and the ability to apply basics of engineering is a prerequisite.

Content:
The lecture on biomass heat and power plants teaches the basics of conceptual design as well as the application of planning software. It also covers the specific design of heat grids. Furthermore, approaches for evaluating combined heat and power stations as well as possibilities for optimization are presented. A seminar paper on a particular power station is completed individually or in groups. The results are presented in a dedicated seminar.

Intended Learning Outcomes:
Students gain the ability to independently analyze the design and economic viability of biomass heat and power plants and to evaluate these using specific criteria. They can shed light on and apply appropriate optimization measures with respect to performance and efficiency of combined heat and power plants.

Teaching and Learning Methods:
Lecture, group and individual work on case examples, seminar with presentation of seminar paper.

Media:
Lecture and script, case examples including solutions, software, presentations in a related seminar

Reading List:
Kaltschmitt; Hartmann (2009): Energie aus Biomasse: Grundlagen, Techniken und Verfahren. Springer Verlag
Wöllauer, P. (2007): Energie aus Biomasse. Books on Demand GmbH
Strauß; Karl (2009): Kraftwerkstechnik zur Nutzung fossiler, nuklearer und regenerativer Energiequellen. Springer Verlag
Dürr, M. (2011): Bioenergie und Nachhaltigkeit: Ein Bewertungsmodell für Bioenergieprojekte unter dem Aspekt der Nachhaltigkeit. Diplomica Verlag
Karl, J. (2006): Dezentrale Energiesysteme: Neue Technologien im liberalisierten Energiemarkt. Oldenburg Verlag

Responsible for Module:
Stefan Wittkopf (stefan.wittkopf@hswt.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

WZ1134: Marketing for Renewable Resources | Marketing für Nachwachsende Rohstoffe

Version of module description: Gültig ab winterterm 2015/16

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:
Assessment involves a written examination (120 minutes). Students have to demonstrate their ability to recognize marketing problems and find possible solutions as well as applying them to products or services within a limited period of time. No external tools are allowed in the examination. The two parts of the module ("Marketing Renewable Resources" and "Marketing Investment Products") will add up 50 % to the final grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
This module will focus on two important areas of marketing, as the topic is an extremely varied one. Module content is therefore divided into "Marketing Renewable Resources" (LV1) and "Marketing Investment Products"(LV2).

1. Marketing renewable resources
1.1) Strategic marketing of products and services based on renewable resources
1.2) Target groups for products made from renewable resources and what determines their behavior
1.3) Applying the marketing mix to products or services involving renewable resources
1.4) Characteristics of marketing products / services aiming at sustainability

2. Investment products marketing
2.1) Basic task fields in marketing investment products, various transaction types

2.2) Characteristics of transactions and service offerings in the B2B sector, linking value chains, customer integration and service bundles
2.3) Buyer behavior of organisations, uncertainty and information as behavior-determining factors during the buying process, concepts for the analysis of buying centers

Intended Learning Outcomes:
Students who have taken this module will be able to apply tools for the strategic and operational marketing to specific products or services based on renewable resources and illustrate the characteristics of marketing investment products. Thereby, they can identify appropriate target groups for such products (specific products or services) and analyze their behaviour. Furthermore, when developing suitable marketing strategies and concepts students are aware of the characteristics of products and services aiming at sustainability. In addition, students can apply key theoretical approaches to the buyer behaviour of organisations.

Teaching and Learning Methods:
This lecture given by teaching staff will present the two marketing areas "Marketing Renewable Resources" and "Marketing Investment Products", which is the most effective way of teaching such comprehensive issues.

Media:
Presentation, Script

Reading List:
Nieschlag, P., Dichtl, E., Hörschgen, H., 2002. Marketing, 19 ed. Dunker und Humblot, Berlin.
Pepels, W., 2004. Marketing. Oldenbourg.
Ritzerfeld, U., 1993. Marketing-Mix-Strategien in Investitionsgütermärkten; Entwicklung und Stimulation marktstrukturspezifischer Strategien. Gabler, Wiesbaden.
Winkelmann, P., 2008. Marketing und Vertrieb. Oldenbourg, München.
Backhaus, K.; Voeth, M.: 2012 Industriegütermarketing, München
Fließ, S.: 2000. Industrielles Kaufverhalten in Kleinaltenkamp, M.; Plinke, W. (Hrsg.): Technischer Vertrieb, Berlin/Heidelberg
Meffert, H., 2012. Marketing. Gabler, Wiesbaden.
Richter, H. P. 2001. Investitionsgütermarketing, München/Wien 2001

Responsible for Module:
Klaus Menrad (klaus.menrad@hswt.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

WZ1138: Investment, Financing, Money and Capital Markets | Investition, Finanzierung und Kapitalmärkte

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:**	**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:
Written examination (90 minutes): The students' knowledge is assessed with the help of a comprehensive and coherent case study. This includes students’ ability to make and justify investment decisions as well as identify and justify a required financing for investment measures and a necessary use of guarantees.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of (financing) mathematics

Content:
Investment calculation methods / techniques (static, dynamic), instruments for financing and credit insurance, and debtor related problems will be commented with the aid of case examples.
1. Introduction and basics of investment calculation
2.Taxes in investment calculation
3. Optimum replacement time for investment products
4. Uncertainty and sequential decisions
5. Optimum portfolios
6. Financial planning (involves a field trip)
7. Internal financing and self-financing (involves a field trip)
8. External financing (borrowing and own finance)
9. Loan securities
10. Simultaneous investment and programme planning (field trip)
11. Detailed real-life cases

WZ1138:

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

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

Module Description

WZ1153: Phytopharmaceuticals and Medicinal Plants | Phytopharmazie und Heilpflanzen

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:**
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 Minuten.
eine schriftliche Klausur über den gesamten Vorlesungsstoff, Vorträge werden nicht bewertet.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Organische und anorganische Chemie, Botanik

Content:
Definition einer Heilpflanze und eines Phytoarzneimittels. Stellung der Phytoarzneimittel innerhalb der Arzneimitttellehre. Arzneiliche Zubereitungen (Teedrogen, Lösungsmittelextrakte, sCO2-Extrakte, Wasserdampfdestillation, Reinsubstanzen) Wirkungsbestimmende Inhaltsstoffe und häufige Wirkmechanismen (Inflammationkaskade, Infektionen, Gerinnungssystem, Nervenleitunsprozesse, Verdauungsapparat) Typische Heilpflanzen aus europäischen Anbaugebieten. Internationaler Heilpflanzenhandel. Wichitge Substanzklassen (Terpene, Steroide, Coumarine, Alkaloide, Vitamine, Saccharide). Qualitätsbestimmung und typische Methoden (Chromatographische Analytik. DNA-Fingerprinting. Infrarot- und andere spektroskopische Techniken). Verfälschungen und chemische Rassen. Arzneimittelregulation (Zulassung, Monographie) Verwendung von Heilpflanzen in der Praxis

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen können die Studenten die Herstellung einiger Phytoarzneimittel aus typischen Arzneipflanzen von der Ernte bis zur Qualitätskontrolle überblickshaft wiedergeben. Die Studenten sind in der Lage, an typischen Beispielen den Zusammenhang zwischen medizinischer Wirkung und chemischen Inhaltsstoffen abrufen. Die

Teilnehmer am Praktikum sind in der Lage, einfache analytisch-chemische Handgriffe zur Pflanzenanalyse anzuwenden bzw. deren Ergebnisse zu beurteilen

Teaching and Learning Methods:
Vorlesung (Vortrag durch Lehrpersonal mit PP-Medien, Büchern und sonstigem schriftlichem Material) Labor-Praktikum (Experimentieren der Studenten unter Anleitung)

Media:
PP-Präsentationen und gedruckte Versionen als Unterlage. Laborgeräte zum Experimentieren, vorgefertigte Übungsanalysen

Reading List:
Deutschmann, F., Hohmann, B., Sprecher, E., Stahl, E., Pharmazeutische Biologie, 3 Bde., G. Fischer Verlag, 1992

Responsible for Module:
Herbert Riepl (h.riepl@wz-straubing.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

WZ1158: Enzyme Technology | Enzymtechnologie

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer 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:
Assessement includes a written examination (worth 70%, 60 minutes) in which students show that they are able to reproduce different enzymatic conversions without tools. Answering questions in part requires proper formulation and outlining process and reaction schemes. In addition, calculation tasks have to be worked out. Assessment of the seminar takes an oral presentation and a written report on completed experiments (worth 30%)

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Lecture provides a broad overview of enzyme use in processing renewable resources; the development of unknown enzyme-catalyzed reactions is described in detail. Various topics are covered with the help of examples: enzyme properties relevant to the industry, essential enzyme classes and corresponding mechanisms of action, whole cell catalysis vs. enzyme catalysis, biocatalysis vs. classical chemical catalysis, methods of enzyme immobilization, enzymes in aqueous and non-aqueous systems, enzymatic reactions in combination with chemical reactions, large-scale provision of enzymes, search for unknown natural enzyme activities, approaches in the field of molecular biology and protein chemisty to optimize enzymes (rational methods, computer-aided methods, evolving and combined procedures, high-throughput technologies, robotics).

Intended Learning Outcomes:
After completion of the module, students are familiar with various enzymes and the reactions they catalyze. In addition, they are able to manage and realize the chemical transformation of biobased molecules in a real laboratory setting. Students know how to analyze the behavior and limitations

of enzymes, determine the respective advantages and disadvantages as well as point out new approaches to enzyme development.

Teaching and Learning Methods:
Lecture: talks by teaching staff,
Seminar: students work out a topic, individually or in small groups, with subsequent presentation of the results (talk)

Media:
PowerPoint and blackboard, slide notes will be handed out

Reading List:
Wolfgang Aehle, Enzymes in Industry, Wiley-VCH-Verlag Weinheim, 2007; Andreas Bommarius und Bettina Riebel, Biocatalysis, Wiley-VCH, 2004; Klaus Buchholz, Volker Kasche, Uwe T. Bornscheuer, Biocatalysts and Enzyme Technology, Wiley-VCH, 2005; Wim Soetaert, Erick J. Vandamme, Industrial Biotechnology, Wiley-VCH, 2010
Directed Enzyme Evolution: Screening and Selection Methods (Methods in Molecular Biology) und Directed Evolution Library Creation: Methods and Protocols (Methods in Molecular Biology), beide Frances H. Arnold, George Georgiou (Hrsg.), Springer, Berlin; Protein Engineering Protocols (Methods in Molecular Biology), Katja M. Arndt und Kristian M. Muller (Hrsg.), Springer, Berlin.

Responsible for Module:
Volker Sieber (sieber@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

WZ1159: Modern Methods in White Biotechnology | Moderne Methoden der weißen Biotechnologie

Version of module description: Gültig ab winterterm 2015/16

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:
Assessment requires the presentation (30 minutes) on a current topic in the area of white biotechnology. Students demonstrate their ability to apply methods learnt on the course, including their advantages and disadvantages with respect to the specific topic. Students apply contents and methods taught during lectures and tutorials to develop a problem-solving strategy and target the specific problem.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic biology, industrial microbiology and comparable modules

Content:
This module provides a broad overview of methods used in white biotechnology (enzymology, mutagenesis, strain optimization, gene bank setup, metabolic engineering, synthetic biology). Focus is set on special methods of modern white biotechnology, such as so-called omics-technologies. The importance of those methods to specific approaches in the field of white biotechnology is demonstrated by selected case examples. That includes not only detailed descriptions of the required equipment, but also the procedures to be applied..
In the seminar, students revise their knowledge of the lecture content with the help of case examples and independent study of a technical topic (either individually or in small groups). Finally, they will present their findings.

Intended Learning Outcomes:
After completion of the module, students are able to analyze possible applications in white biotechnology, in particular omics-technologies. They have understood the potential and limitations

of individual methods and processes, and could apply those to the use of renewable resources. Students are also able to adapt asssay and analysis methods used in biotechnology.

Teaching and Learning Methods:
Lectures: presentation by teaching staff; seminar: students reflect in-depth on lecture contents with the help of case examples and independent study of technical topics, either individually or in small groups. They conclude with a presentation of findings. By researching the latest literature, students can directly link theory to practical application.

Media:
PowerPoint, blackboard

Reading List:
Noureddine Benkeblia: OMICs Technologies: Tools for Food Science, 978-1439837061

Responsible for Module:
Jochen Schmid (jochen.schmid@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

WZ1161: Industrial Microbiology | Industrielle Mikrobiologie

Version of module description: Gültig ab winterterm 2015/16

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:
Comprehension questions are to be answered in a written examination (60 minutes) to demonstrate the students' knowledge and understanding of use and handling of microorganisms for industrial production.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics in biology, cell biology and molecular biology, bioprocess engineering

Content:
The module offers a broad overview of microorganisms in industrial production and application. The significance of microbial procedures in índustry will be explained with the help of examples. Methods for getting grips on micobial metabolism pathways and their influence on production will be presented. The physiology of microorganisms with peculiar metabolism and intriguing industrial relevance are described in detail. In addition, focus will be set on protein production and industrial fermentation processes. Taking into account the current changes in resources of industrial interst, necessary modulations of current microorganisms will be discussed.

Intended Learning Outcomes:
After conclusion of the module, students can understand possible applications of microorganisms in large-scale industrial processes, as well as their behavior and limitations. In addition, they can find ways to develop new microbiological procedures and applications.

Teaching and Learning Methods:
Lectures given by lecturers using Powerpoint presentations and blackboard. Knowledge and understanding is deepened in ongoing discussions and expert discussions in small groups.

Tutorial: rehearsals of important metabolic pathways and procedures. Exercises including the description and analysis of large-scale fermentation processes.

Media:
PowerPoint, blackboard

Reading List:
Richard H. Baltz, Arnold L. Demain, Julian E. Davies.: Manual of Industrial Microbiology and Biotechnology, 978-1555815127; Nduka Okafor: Modern Industrial Microbiology and Biotechnology von von Science Publishers, 978-1578085132.

Responsible for Module:
Jochen Schmid (jochen.schmid@mytum.de)

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

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

WZ11

Dünnschichtchromatographie, Kapillarviskosimetrie, HPLC, Infrarotspektroskopie, spezielle Methoden zur Polymercharakterisierung).

Intended Learning Outcomes:
Nach Praktikumsteilnahme besitzen die Studierenden ein vertieftes Verständnis für die ausgewählten Beispielprozesse und die zugrundeliegenden Reaktionen. Sie sind mit dem Arbeiten in chemischen und mikrobiologischen Labors in den Grundzügen vertraut und in der Lage, die vermittelten speziellen experimentellen und analytischen Methoden mindestens in den Grundzügen anzuwenden und Laborexperimente korrekt zu protokollieren.

Teaching and Learning Methods:
Laborexperimente in Kleingruppen unter Anleitung mit vorheriger Einführung in die Theorie zu den einzelnen Experimenten, sowie Auswertung der Ergebnisse in Form von Versuchsprotokollen

Media:
Praktikumsskript, ppt-Präsentationen, Tafelanschrift, Labor, Laborgeräte

Reading List:
Praktikumsskript

Responsible for Module:
Doris Schieder (doris.schieder@tum.de)

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

Doris Schieder (doris.schieder@tum.de)

Cordt Zollfrank (cordt.zollfrank@tum.de)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1164: Advanced Practical Course Chemistry | Chemisches Praktikum [ChemP]

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** German	**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:
During the course, experiments are supplemented by assessed oral examinations. Questions are based on the theoretical parts of the script, the practical experiments and related safety issues. This serves to examine acquired knowledge and contributes towards critical thinking in relation to potential risks.
At the end of the course, students will submit a report on each experiment carried out which contribute 50% to the overall assessment.
In the examinations and reports, students demonstrate their ability to apply acquired experimental and analytical techniques and correctly document laboratory experiments.
There is a written examination (60 minutes) at the end of the course. Here, students show that they have understood the chemical reactions underlying the experiments in addition to the background to the experiment procedure. The written examination and the completed reports both contribute 50% to the final grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Experience in safe handling of chemicals. Recommended: Participation in module "Basics of chemistry" and "Introduction to material use" or comparable knowledge.

Content:
Preparatory seminar including security advices. The contents include the explanation of practical methods and basics of data analysis. Practical experiments to extend the students' knowledge: renewable resources, vegetable fats and oils, terpenes, amino acids and proteins, sugar and polysaccharides, chemical technologies for the conversion of materials, polymers, sustainable

chemistry, catalysis, isolation of naturally ocurring substances, current synthesis methods, analytics.

Intended Learning Outcomes:
After participation students know basic steps in laboratory work, e.g. to weigh out, instrument setting and operation, dosing, extaction, destillation and chromatography. They are also aware of various reaction types and analysis methods relevant to material use of renewable resources and can apply them to laboratory experiments.

Teaching and Learning Methods:
A preparatory course includes security advices and explanations of practial methods and basics for the analysis of experiments. Afterwards, students work individually on laboratoy experiments and document their results in reports. Experiments are supplemented by assessed oral examinations.

Media:
Script, laboratory equipement

Reading List:
Practical course script

Responsible for Module:
Cordt Zollfrank (cordt.zollfrank@tum.de)

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

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

WZ1176:

Media:
Laboratory, laboratory equipment, technical literature

Reading List:
Relevant specialist literature will be announced to the students on the basis of the individual topic at the beginning of the internship

Responsible for Module:
Doris Schieder doris.schieder@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungsprakikum Chemie Biogener Rohstoffe (Praktikum, 15 SWS)
Sieber V [L], Abbas Nia A, Al-Shameri A, Arana Pena S, Dsouza Z, Fornoni E, Friedrichs J, Fuchs A, Giustino A, Grundheber J, Hofer N, Hörnschemeyer K, Hupfeld E, Kampl L, Köllen T, Liu Y, Malubhoy Z, Marosevic M, Matena F, Mayer M, Ostertag T, Raga Carbajal E, Rau M, Romeis D, Rühmann B, Scheerer J, Schieder D, Schulz M, Sieber V, Siebert D, Steiger M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1180: Introduction Energy Conversion and Energy Economics | Einführung Energiewandlung und Energiewirtschaft

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:
Assessment takes the form of a written examination (60 minutes). Students demonstrate their understanding of connections relevant to energy conversion, the use of renewable resources as a source of energy, energy supply in general, and the current political and economic situation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The module deals with the basics of the heat, electricity and fuel market and the use of renewable raw materials, including an introduction to simple technical systems and current topics relating to the energy industry. For example, electricity trading, CO2 trading and the situation of generation plants are dealt with.
In exercises, small examples of the economic efficiency (production costs) of plants are calculated (e.g. combined heat and power generation).

Intended Learning Outcomes:
After participation students understand the basics of energy conversion with regard to heat, electricity and fuel. They can explain the role of market forces in in the electricity and CO2 trade as well.

Teaching and Learning Methods:
The module comprises lectures and tutorials (including an excursion). The contents are presented in talks and presentations. To deepen their knowledge students shall be encouraged to study the

literature and examine with regards to content the topics. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Presentations, practical course

Reading List:
Kaltschmitt, M.; Hartmann, H.; Hofbauer, H.: Energie aus Biomasse, 2. Auflage, Springer, ISBN 978-3-540-85094-6, 2009
Karl, J.: Dezentrale Energiesysteme, Oldenbourg, ISBN 3-486-27505-4, 2004/

Responsible for Module:
Matthias Gaderer gaderer@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

WZ1182: Energetic Use of Biomass | Energetische Nutzung von Biomasse

Version of module description: Gültig ab winterterm 2015/16

Module Level:	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:
Assessment consists of a written examination (60 minutes) based on the various potential uses of biomass for energy and a presentation on a concept students have developed individually regarding the use of biomass. The written part constitutes 60% of the grade and the presentation 40%.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation at "Basics of engineering" or appropriate knowledge in engineering (thermodynamics).

Content:
Lectures are dedicated to potential technology for using biomass as a source of energy. In particular, heat generation, energy conversion, power-heat coupling and the process for generating gaseous and fluid sources of energy are discussed. In addition, the generation of biogas (fermentation process) is discussed in detail. However, as there is another lecture dedicated to this topic, this section will be restricted to the technical basics. Practical exercises focus on conception and planningof plants. As part of a seminar, participants should develop voluntary examples and assess these using an economic efficiency calculation. For the tutorial, students work individually in the group on a concept for biomass use. This concept is analyzed in regard to technical and economic feasibility with the result being presented and assessed in a presentation.
Learned content is put into practice during an excursion to a biomass plant.

Intended Learning Outcomes:
After completion of the module, students are able to understand and evaluate the various systems for use of biomass. They have got a broad overview of options. In addition, they are able to develop a relevant concept, argue in favour of it, and evaluate the economic profit, if possible.

Teaching and Learning Methods:
Lecture (talk by teaching staff) with media, tutorial on calculation of examples, presentation of a voluntary concept regarding biomass use

Media:
Presentation, script, examples, excursion

Reading List:
Script/
Kaltschmitt, M.; Hartmann, H.; Hofbauer, H.: Energie aus Biomasse, 2. Auflage, Springer, ISBN 978-3-540-85094-6, 2009
Karl, J.: Dezentrale Energiesysteme, Oldenbourg, ISBN 3-486-27505-4, 2004/

Responsible for Module:
Matthias Gaderer (gaderer@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

WZ1193: Biogas Technology | Biogastechnologie [BiGA]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**To**		

processes in biogas plants and can differentiate between various influencing factors. They are also aware of various processes for the use of biogas and understand their advantages and disadvantages. Students recognize the meaning of biogas technology for sustainable energy supply. Students have a good knowledge of legal and economic framework conditions in the field of biogas generation and they are able to conceptualize basic biogas plants.

Teaching and Learning Methods:
Lectures given as presentations, with the help of a blackboard and interactive elements, in particular group work on case examples; optional: excursion to a biogas plant to deepen acquired knowledge in a real-life setting

Media:
PowerPoint presentation, slide notes, exercise sheets

Reading List:
D. Deublein, A. Steinhauser, Biogas from Waste and Renewable Resources - An Introduction, Wiley-VCH, 2010, ISBN-13: 978-3-527-32798-0, ISBN-10: 3-527-32798-3

Responsible for Module:
Doris Schieder (doris.schieder@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

WZ1240: Advanced Simulation Topics | Fortgeschrittene Simulationsthemen

Version of module description: Gültig ab winterterm 2016/17

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 performance is provided in the form of a project work. By working on a more in-depth task, the students demonstrate that they can select and apply methods appropriate to the problem. In the written elaboration, the participants show that they can establish connections, correctly classify facts and adequately present the results achieved.

Repeat Examination:

(Recommended) Prerequisites:
Modules Physics, Mathematics, Simulation and Optimization in Power Engineering, Matlab +Programming Knowledge

Content:
Depending on the topics chosen for the seminar paper, a selection of the following topics will be covered:
advanced concepts of Matlab programming & visualization
- practical modelling & simulation (e.g. motor process simulation, heat conduction equation)
- Import and processing of measurement data
- Advanced simulation and modelling (e.g. neural networks in practice, partial differential equations)
- Deepening theoretical concepts of modelling (e.g., finding nonlinear model parameters, evolutionary algorithms, Fourier analysis, different types of neural networks)

Intended Learning Outcomes:
After participating in the module events, the participants will understand advanced methods for modelling, simulation and optimisation and will be able to select and apply methods appropriate to

the problem at hand. The chosen approach and the essential implementation steps are presented and explained in a seminar paper.

Teaching and Learning Methods:
The module includes a seminar part. Here the students work out a solution for a more extensive problem on their own. This usually requires the preparation of more extensive programming tasks and the presentation and justification of the chosen approach in a seminar paper. To support this activity, in the lecture part of the module more in-depth contents are imparted in the lecture and practiced in the exercise part of the module by independent processing of exercises by the students. In the context of the exercise an accompaniment of the seminar work is offered in addition.

Media:
Presentations, slide scripts, blackboard writing, demonstration of programs/scripts

Reading List:
O. Nelles, Nonlinear System Identification, Springer, Berlin, 2010
M. T. Hagan, H. B. Demuth, M. H. Beale, O. De Jesus, Neural Network Design, ISBN 0-9717321-1-6, http://hagan.okstate.edu/NNDesign.pdf+B32

Responsible for Module:
Josef Kainz josef.kainz@hswt.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

WZ1259: Experiment Design and Planning in Chemistry | Projektierung in der Chemie

Version of module description: Gültig ab winterterm 2016/17

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:
The first part of the assessment takes the form of project work, including e.g. planning, laboratory work and a written evaluation of the project. This is to demonstrate that students can practically apply the acquired methods (e.g. literature research or pipetting) in order to design and work on small projects independently. The second part of the assessment includes a ten-minute presentation, in which the results are briefly introduced to the class and lecturers. This serves the assessment of students' communicative proficiency in discussing scientific topics in front of an audience. Project work accounts for two-thirds of the grade, the presentation makes up the remaining one-third.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge and experience of laboratory work, such as introduced in the modules WZ 1680 (LV3641) and WZ1681 (LV968 and LV981)

Content:
The module covers various methods that are required for independent project work. The lecture first outlines the content and time requirements of chemistry projects as well as the main sources of error. It covers everything from literature research to writing reports. Finally, practical methods (pipetting, weighing, preparation of solutions and dilutions) are introduced by exercises to deepen the students' theoretical knowledge and allow them to plan and perform projects independently (starting from literature research until experiments realized in a laboratory).

Intended Learning Outcomes:

Module Description

WZ1283: Sustainability | Nachhaltigkeit

Version of module description: Gültig ab summerterm 2017

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 5	**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

WZ1600: Physics | Physik [Phys]

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	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:
Achievement of desired learning objectives shall be verified in a written final exam (90 minutes). There, the students demonstrate that they know and understand the physical concepts imparted during the lecture. By solving specific physical problems the students demonstrate that they are able to also use acquired concepts in a solution-oriented way in simple cases.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Good A-level knowledge of mathematics, prep courses mathematics/ physics (usually offered shortly before semester start)

Content:
The module of physics provides an introduction into classical physics. The module introduces into the math-based approach of physics for nature description. The lecture includes the basics of mechanics, thermal engineering, electricity and optics.

Intended Learning Outcomes:
The module serves to acquire physical basics. The students know the basic concepts of mechanics, thermal engineering, electricity and optics. Based on examples treated during the lecture and deepening during the exercise the students learn how to use these concepts to solve simple physical problems. So a solid basis will be created to understand the following course content (e.g. Thermodynamics, energy technology) and to use acquired knowledge in an advanced way there.

Teaching and Learning Methods:
Lecture (oral presentation by teaching staff including filling in the gap text lecture notes, writing on the board, PP media, demonstration experiments), exercise (deepening of course contents with tutors) with work in small groups.

Media:
Gap text lecture notes, writing on the board, presentations, demonstration experiments

Reading List:
"U. Harten: Physik, Einführung für Ingenieure und Naturwissenschaftler (Physics, Introduction for Engineers and Scientists), 4th edition 2009, Springer
Paul A. Tipler: Physik (Physics), Spektrum (Panoply), Akademischer Verlag Heidelberg, Berlin, Oxford"

Responsible for Module:
Kainz, Josef; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Physics (Lecture) (Vorlesung, 2 SWS)
Kainz J [L], Kainz J

Physics (Exercise) (Übung, 2 SWS)
Kainz J [L], Kainz J, Sun J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1601: Mathematics | Mathematik

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Learning outcomes shall be verified in a written test (90 min). Tasks shall be specified by means of which the students are to demonstrate that they know the mathematical methods imparted as part of the module and that they have understood and are able to apply them for specific case studies.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge in mathematics corresponding to basic knowledge of A-level students.

Content:
Selected mathematical methods required for calculations in the scientific, engineering or economic field, especially analysis (e.g. complete induction, differential and integral calculus, arithmetic progression and series), calculations with real and complex numbers as well as selected chapters of linear algebra (e.g. linear equation systems, matrices, eigenvalues and eigenvectors).

Intended Learning Outcomes:
The students know the most important mathematical methods required for calculations in the scientific, engineering or economic field. They have understood these methods and are able to calculate specific case studies and perform basic mathematical proof by means of complete induction.

Teaching and Learning Methods:
Lecture, presentation and associated exercises with independent processing and teamwork of specific examples. Mathematical methods shall be presented during the lecture. Within the scope of the exercise their application shall be practised based on specific case studies.

Media:
Digital presentation, writing on the board, exercise sheets

Reading List:
Forster, Otto 2004. Analysis 1 Vieweg Teubner Verlag

Responsible for Module:
Dominik Grimm (dominik.grimm@hswt.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Mathematics (Lecture) (Vorlesung, 2 SWS)
Grimm D [L], Grimm D

Mathematics (Exercise) (Übung, 2 SWS)
Grimm D [L], Grimm D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1603: Biology Basics | Grundlagen Biologie

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**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:
Learning outcomes shall be verified in a written test in which the students are to call up and remember important basics of biology without tools. Besides the students shall demonstrate that they are capable of recognizing and solving a problem in a given time by answering questions of comprehension relating to treated basic biological and biotechnological processes. The answering of the questions requires own formulations. Thus correct memory of important technical terms shall be verified as well. Participation in laboratory exercises shall be deemed an academic performance. The latter shall not be integrated into the overall performance. Exam duration: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in biology and chemistry corresponding to basic knowledge of A-level students.

Content:
Lecture: Basics of cell biology (textural cell structure, differences between procaryotic and eucaryotic organisms, theoretical basics of microscopy), genetic flow of information and basis of molecular genetics (e.g. structure of DNA, transcription, translation, DNA duplication), important metabolic pathways (e.g. Glycolysis, citrate-cycle), basics of biological system at the example of selected beneficial organisms (e.g. coli, S. cerevisiae, algae, fungi), use of microorganisms in industrial biotechnology (e.g. ethanol fermentation, ABE fermentation, protein synthesis).
Exercises: seminar-style and practical exercises for lectures, basic introduction into laboratory work, basics of microbiological working, microscopic examination of different microorganisms

Intended Learning Outcomes:
After attending the module the students possess basic knowledge about structure and function of biomolecules. They know important components of procaryotic and eucaryotic cells and are able to differentiate between these forms of life. They know the basics of the genetic flow of information and the most important metabolic pathways and are able to assign bacteria, fungi and plants to higher- ranking systematic groups. Furthermore the students are able to convey technical terms and define processes and are able to use their knowledge to solve issues. After completing the module participants are familiar with the microscope. They are capable of identifying and designating microorganisms and master the basics of microbiological working. These abilities are the basis of further practical working in the subsequent course of the study.

Teaching and Learning Methods:
Lecture and associated exercise including independent processing of specific examples. Selected associated experiments in the (micro)biological laboratory. Seminar-style exercises for lectures.

Media:
Presentation, writing on the board, laboratory equipment. Optional: Script

Reading List:
• „Allgemeine Mikrobiologie (General Microbiology)“ by Georg Fuchs published by Thieme, Stuttgart (aperback - 11 October 2006)
• "Brock Mikrobiologie" von Michael T. Madigan and John M. Martinko, Pearson, 11th edition (2008)
• "Biologie" by Neil A. Campbell and Jane B. Rice, Pearson, 8th edition (2011)

Responsible for Module:
Josef Sperl (josef.sperl@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

WZ1607: Basics Silviculture | Grundlagen Waldbau [BiS]

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**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:
In a test the students shall give answers to silvicultural issues in their own words and without tools. In doing so definitions of different site characteristics and consequences for silviculture shall be given in short answers. In longer answers different silvicultural concepts shall be illustrated. One or more trees of the twenty economically most important tree types shall be determined by means of clear photos and/or branches with leaves. Type of exam: In writing, Exam duartion: 60 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics of biology: WZ 1603
Basics of plant production WZ 1604
Basic knowledge of plant build-up, nutrient cycles, soil structures.

Content:
The module aims at providing to students basic knowledge of cultivation, breeding, harvest of trees as well as botany and dendrology. Special techniques and instruments of silviculture shall be imparted: Techniques of reforestation,
young plantation care,
Thinning,
Pruning, Forestry systems as well as
strategies for timber production with hardwood and softwood tree types.
For this purpose parts of location study and teaching of forest soils with pedogenesis and soil chemistry shall be imparted.

Intended Learning Outcomes:
After attending the module the students understand the most important basic forms of forest treatment as well as its ecological special features and the structure and dynamic of forest resources. The students recognize different forest-related tree types and are able to distinguish their demands. After attending this module the students are additionally able to explain different forest soils and different silvicultural farming strategies by using the given information from the fields of forest ecology and location study. Silvicultural techniques shall be recognized and may be used accordingly. The most important forest soil types shall be recognized by means of cross-sections.

Teaching and Learning Methods:
The course of basics of silviculture consists of one lecture, preparing and giving a speech for which material research is necessary and first rhetoric skill are trained. A study trip into the forest and lectures held by qualified personnel from practice on site at different stations with common rounds of questions shall open a deeper insight into the topic. For that purpose also first determination exercises shall be performed at the object in the forest. A cut out soil profile serves to recognize theoretically acquired knowledge of soil horizons.

Media:
In the course the following media forms shall be used:
Script, powerpoint, films, for lectures also blackboard and flipchart, for determination exercises also branches and leaves to be determined. Study trip.

Reading List:
Burschel, P. & Huss, J. 1987. Grundriss des Waldbaus (Ground Plan of Silviculture). Ein Leitfaden für Studium und Praxis (A Guide for Study d Practice). Parey, Hamburg und Berlin. 352 S.
Elverfeldt, Freiherr von A. Rittershofer, F. 1999. Waldpflege und Waldbau (Forest Management and Silviculture). Für Studium und Praxis (For Study and Practice). 492 S.

Responsible for Module:
Alexander Höldrich (alexander.hoeldrich@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung
Grundlagen Waldbau
3 SWS
Übung
Grundlagen Waldbau
1 SWS

Alexander Höldrich (alexander.hoeldrich@tum.de)
Cordt Zollfrank (cordt.zollfrank@tum.de)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1609: Scientific Working | Wissenschaftliches Arbeiten

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**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:
Concepts of scientific working shall be practically applied and deepened by the preparation of homework. Homework shall be done as an academic performance and shall not be integrated into the overall performance. Teamwork is possible here. Exam achievement shall be done by a written test. In this test students shall prove that they are familiar with the rules of good scientific working, that they master a methodological approach to planning, execution, evaluation and discussion of a scientific work and that they are able to take a very critical look at experiments, data collection, data processing and evaluations. No tools are allowed. Exam duration: 60 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
As scientific working is essential for all disciplines the module may be attended by students of all kinds of studies.

Content:
The module of scientific working shall impart knowledge for preparing academic theses satisfying a scientific demand. The students discover different methods for scientific working as well as practical working methods and formal guidelines. The course shall illustrate how to prepare the state of knowledge of research as well as topic formulation at the beginning of a scientific work. An important focus of the module is research of literature. Students shall be taught how to handle libraries and quotable sources and shall be explained different possibilities of citation. Form and writing style as well as structuredness and goal orientation (thread) as essential elements of a scientific work shall be part of teaching in the module. Besides independence of participants as well as skills in working collaboratively and taking a very critical look at own results and approaches shall be developed.

Intended Learning Outcomes:
After successfully completing the module the students shall be qualified in preparing a scientific work by well-founded methodological approach. Participants also master a scientifically suitable form and language. They know the laws of good scientific working, correct citation methods and where scientific misconduct results in. In addition the students are able to plan a scientific work and estimate time requirement in a realistic way. Subsequent to this lecture they are able to take a critical look at an experiment and perform data collection, processing, evaluation and discussion.

Teaching and Learning Methods:
Lecture illustrating case studies. In the exercise ... shall be given and the term paper be mentored.

Media:
Presentations, slide scripts

Reading List:
Eco, U.; Schick, W. (2010): Wie man eine wissenschaftliche Abschlußarbeit schreibt (How to Write a Scientific Thesis). Heidelberg: UTB
Heesen, B. (2009): Wissenschaftliches Arbeiten (Scientific working). Vorlagen und Techniken für das Bachelor-, Master- und Promotionsstudium (Templates and Techniques for Bachelor, Master and Doctoral Studies). Berlin: Spinger
Rückriem, G. M.; Stary, J.; Franck, N. (2009): Die Technik wissenschaftlichen Arbeitens (Technique of Scientific Working). Eine praktische Anleitung (A Practical Instruction). Stuttgart: UTB
Davies, M. B. (2007): Doing a successful research project. Using qualitative or quantitative methods. Basingstoke: Palgrave

Responsible for Module:
Cordt Zollfrank (cordt.zollfrank@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Wissenschaftliches Arbeiten (Übung) (Übung, 1 SWS)
Van Opdenbosch D [L], Van Opdenbosch D

Wissenschaftliches Arbeiten (Vorlesung) (Vorlesung, 3 SWS)
Van Opdenbosch D [L], Van Opdenbosch D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1611: Statistics | Statistik

Version of module description: od

Media:
Lecture script, exercise sheets

Reading List:
Fahrmeir, Künstler, Pigeot, Tutz: Statistik - Der Weg zur Datenanalyse, Springer Verlag, ISBN: 978-3-642-01938-8; Kauermann, Küchehoff: Stichproben - Methoden und praktische Umsetzung mit R, Springer Verlag, ISBN: 978-3-642-12317-7

Responsible for Module:
Prof. Clemens Thielen

Courses (Type of course, Weekly hours per semester), Instructor:
Statistics (Exercise) (Übung, 2 SWS)
Thielen C [L], Thielen C

Statistics (Lecture) (Vorlesung, 2 SWS)
Thielen C [L], Thielen C
For further information in this module, please click campus.tum.de or here.

WZ1614:

related working methods. He distinguishes different forms of economy and is able to classify them according to economic, social and ecological aspects. He recognises differences of woods, knows various new products produced from wood and understands their production paths.

Teaching and Learning Methods:
The course attendance of forestry and wood consists of one lecture. For this purpose a powerpoint presentation shall be used. A study trip to a wood processing plant including lectures from qualified personnel providing information from experience on site with common rounds of questions provides in-depth knowledge of the production paths. A so-called block determination, i. e. the determination of wood by means of different genuine wood samples, will be performed by a magnifying glass 10x.

Media:
The following forms of media apply:
Script, powerpoint, films, for determination exercises also branches and leaves of shrubs to be determined. Study trip to a company with guided tour of processing and treatment of wood. Determination of wood with a magnifying glass 10x.

Reading List:
Jörg van der Heide, 2011: Der Forstwirt. (The Forester) Publisher: Ulmer (Eugen); Auflage: 5th edition. (September 26, 2011)
Language: German
ISBN-10: 3800155702
ISBN-13: 978-3800155705; D. Fengel, G. Wegener: Wood Verlag Kessel, www.forstbuch.de

Responsible for Module:
Cordt Zollfrank (cordt.zollfrank@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Wood-based Resources (Lecture) (Vorlesung, 2 SWS)
Zollfrank C [L], Röder H, Zollfrank C

Wood-based Resources (Exercise) (Übung, 2 SWS)
Zollfrank C [L], Röder H, Zollfrank C
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1616: Biochemistry | Biochemie

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**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:
Based on a written test it shall be verified to what extent the students have understood basics of enzymology and biochemical metabolic pathways and are able to apply their knowledge concerning the reactions taking place within the scope of kinetic and thermodynamic connections. For that purpose specific computational tasks will also be defined. Exam duration: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the modules "Basics of Chemistry" (WZ 1602) and "Biology" (1603). Basic knowledge concerning structure of elementary natural materials, especially sugars as well as knowledge on chemical groups (acids, aldehydes etc.) as well as their possible reactions are a requirement just like a fundamental understanding of redox reactions.

Content:
Enzymology: Within the module the students shall be introduced into basics of enzyme catalysis. In doing so theories relating to the course of enzymatic reactions, special aspects of kinetics and thermodynamics of enzyme-catalysed reactions, inhibition mechanisms as well as possibilities for calculating kinetic parameters shall be treated inter alia. Metabolism: Basic metabolic pathways such as glycolysis, citrate-cycle or gluconeogenesis shall be presented in the lecture. In doing so it is dealt with the general course of reaction cascades, thermodynamic aspects of energy generation as well as mechanisms of modulation of the individual paths. Beside the lectures the module comprises a seminar part in which students recapitulate basics listened to in the lecture and they shall learn to transfer them to new issues.

Intended Learning Outcomes:
By having participated in the module of biochemistry the students understand the significance of kinetic parameters of enzymatic reactions and will be able to calculate them and apply to new issues. Furthermore the students will be able to specify in detail basic metabolic pathways of the most important classes of substances, understand the regulation systems of the respective paths and will be able to transfer these general biochemical principles to other issues, especially in respect of application in modern biocatalytic processes. By deepening the lecture contents in the seminar the students know how to reasonably classify experimental data into theoretical context and assess both the possibilities and limits of the respective theories and concepts.

Teaching and Learning Methods:
Lecture (speech by teaching staff by using powerpoint presentations, panel pictures, books and other written material), seminar, application of lecture material to specific issues, deepening of lecture material.
Optional: Literature review and paper of the students.

Media:
Presentations, powerpoint, presentation script, exercise sheets

Reading List:
Voet, D. , Voet, J.G., Biochemistry 4th Edition, Wiley-VCH, 2011; Nelson, D.L, Cox, M.M., Lehninger Principles of Biochemistry 5th Edition, WH Freeman, 2008; Berg, J.M, Tymoczko, J.L., Stryer, L., Biochemistry 6th Edition, 2006

Responsible for Module:
Ammar Al-Shameri

Courses (Type of course, Weekly hours per semester), Instructor:
Biochemie (Vorlesung) (Vorlesung, 2 SWS)
Al-Shameri A [L], Al-Shameri A

Biochemie (Übung) (Übung, 2 SWS)
Al-Shameri A [L], Schulz M, Siebert D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1618: Biopolymers | Biopolymere [BP]

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**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:
In the course of the seminar the students independently develop current topics from the field of biopolymers through literature review. As an academic performance they shall elaborate a topic in form of a term paper and present it during the seminar. Teamwork is possible. Exam achievement shall be done as a written test. In this test students shall demonstrate that they are able to classify polymers with respect to structure and function, that they know methods for physical and chemical description and analysis of polymers, that they are able to describe basic synthesis processes and chemical functionalisations of biopolymers and outline biological degradation processes.
No tools are allowed in the exam. Exam duration: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the modules "Basics of Chemistry" (WZ 1602) and "Materials and chemical precursors", "Physics" (WZ 1600) or comparable chemical knowledge.

Content:
The module addresses structure and function of polymers deriving from nature as well as from synthetically manufactured and biodegradable polymers. In this respect it is dealt with the significance of microstructure as well as physical and chemical properties in biological functions for application-related relevance of biopolymers used as raw and functional materials. Polymer-analogous reactions, basic synthesis processes as well as chemical functionalisation of biopolymers (cellulose derivatives) shall be represented. Biological degradation processes in relation to biopolymers shall be discussed. Simultaneously physical and chemical description methods of biopolymers as well as methods for analysing this class of molecules shall be presented.

Based on current scientific publications a topic shall be worked out independently by the students (literature review) and presented to their fellow students during the seminar.

Intended Learning Outcomes:
By attending the module the students are capable of distinguishing biopolymers and classifying them in an application-relevant way. The students acquire basic knowledge to understand biopolymers, their physical and chemical properties and are able to describe them and compare them among each other. Thus they are capable of differentiating biopolymers and chemical synthesis methods in an application-oriented way.

Teaching and Learning Methods:
Lecture, speech by experts using PP media, books and other written material, seminar - independent elaboration of a specialist topic by the students with subsequent presentation.

Media:
Presentations, slide scripts

Reading List:
- G. Habermehl, P. Hamman, Naturstoffchemie (Natural Product Chemistry) Springer, 1992
- D. Klemm, B. Philipp, T. Heinze, U. Heinze, W. W.Wagenknecht,
Comprehensive Cellulose Chemistry; Volume (1) und (2), Wiley-VCH, 1998
- Endres, H.J., Seibert-Raths, A., Technische Biopolymere (Technical Biopolymers), Carl Hanser Verlag, München, 2009

Responsible for Module:
Cordt Zollfrank (cordt.zollfrank@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Biopolymere (Seminar) (Seminar, 1 SWS)
Zollfrank C [L], Zollfrank C

Biopolymere (Vorlesung) (Vorlesung, 2 SWS)
Zollfrank C [L], Zollfrank C
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1622: Accounting and Controlling | Rechnungswesen und Controlling [AC]

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	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:
Exam achievement shall be done in the form of a written test for which a formulary shall be provided as a tool. The students calculate the key performance indicators for business decisions and illustrate decision-making procedures and alternatives based on case studies. They show that they are able to outline and explain business management processes. They demonstrate that they are able to answer questions on accounting and controlling in their own words. Type of exam: In writing, Exam duration: 90 minutes

Repeat Examination:
Next semester

(RecommendedQ

The following topics shall be covered during the course:
1. Introduction into controlling Description of controlling functions, distinction of operative controlling and strategic controlling
2. Cost, revenue, profit and performance accounting: Full-cost accounting, marginal costing, project accounting, revenue accounting, performance accounting
3. Key performance indicators and systems of indicators: Types and function of key performance indicators, financial indicators, balanced scorecard
4. Planning and monitoring: Operative, tactical and strategic planning and monitoring

Intended Learning Outcomes:
After having participated in the module units the students know the basics of external and internal accounting and understand simple concepts of accounting as well as available balance sheets or profit and loss accounts of companies using or manufacturing renewable resources.
Besides they are familiar with the system of cost accounting by means of which the students also perform individual profitability calculations and income statements for the specific interests of companies capable of using renewable resources.

Teaching and Learning Methods:
The module shall mainly be organised as a lecture, i.e. presentations are performed by PP media. Based on book reviews self-instruction will be encouraged.

Media:
Presentations, slide scripts, exercise sheets

Reading List:
Kostenrechnung und Kostenanalyse (Cost Accounting and Cost Analysis), Coenenberg/Fischer/ Günther. Schäffer-Pöschl. 8th edition;
Stibbe, Kostenmanagement (Cost Management), 3rd ed. Oldenburg Verlag München.
Seicht, Moderne Kosten- und Leistungsrechnung (Modern Cost and Performance Accounting), 11th ed., Linde Verlag Wien;
Einführung in die Allgemeine Betriebswirtschaftslehre (Introduction into General Business Economics), Wöhe/Döring, Vahlen, 24th edition;
Grundzüge der Betriebswirtschaftslehre (Main Features of Business Economics), Schierenbeck, Oldenbourg Wissenschaftsverlag, 16th edition;
Buchhaltung und Jahresabschluss (Bookkeeping and Annual Accounts: Mit Aufgaben und Lösungen (Including tasks and solutions),
Döring/Buchholz, Schmidt , 10th edition;
Einführung in das Controlling (Introduction into Controlling), Weber/Schäffer, Schäffer-Poeschel, 13th edition;

Responsible for Module:
Röder, Hubert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Controlling (Vorlesung) (Vorlesung, 2 SWS)
Röder H [L], Pokholkova M, Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1623: Markets and Marketing | Markt und Marketing

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**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:
Exam achievement shall be done in the form of a written test. In this test it shall be proved that both basics of market mechanisms in general as well as special aspects in the markets for products of renewable resources and marketing aspects (basics & especially for renewable resources) will be recognized in limited time and methods for respective solutions can be found.
Type of exam: In wirting, Exam duration: 120 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The module includes the aspects of "Market" but also forms of "Marketing". It gives a first overview on the general economic situation of renewable resources.

LV1: In this module part the students will first be imparted the basics of the role and operation of markets. Furthermore basics about markets of agricultural and forestal raw materials as well as about markets for products of energetic or material use of renewable resources shall be considered. For this purpose the different markets are considered by means of or along selected value-added chains important for the sector of renewable raw materials (e.g. maize --> biogas, rape --> oil/biodiesel; wood/flax/hemp --> natural fiber reinforced plastics; sugar beets--> platform and specialty chemicals).

LV2: Marketing

In this module part the students shall first be imparted basics of strategic and operative marketing (particularly product policy, pricing, distribution and communications policy). These basics will then be applied to the special features of marketing with products based on renewable resources.

Intended Learning Outcomes:
After having participated in the module unit the students understand fundamental mechanisms of action of markets general. They recognize the importance of the major markets in the area of renewable resources and are capable of classifying them by themselves and explaining factors of influence for market trends.
Furthermore the students, after having participated in the module unit, know the basics of general marketing. They are able to adapt the basics to the special features of products made of renewable resources where in this case knowledge of the market or market trends of a product is very important. The interaction of the areas of market and marketing will thus help the students explain corporate strategies and marketing campaigns for companies from the area of renewable rresources and their products.

Teaching and Learning Methods:
With the aid of a lecture held by teaching staff the both sections ("Markets", "Marketing") of the module shall be presented. By using this method the comprehensive volume of topics can best be worked up.

Media:
Scripts

Reading List:
Documents from: Agency of Renewable Resources, the German Ministry of the Environment, Ministry of Agriculture, Eurostat, FAO, OECD and other international organisations.
Kotler et al. (2002): Grundlagen des Marketing (Basics of Marketing). Kreutzer (2007): Praxisorientiertes Marketing - Grundlagen - Instrumente - Fallbeispiele (Practice-oriented Marketing - Basics - Tools - Case Studies). Bruhn (2010): Marketing: Grundlagen für Studium und Praxis (Basics for Study and Practice).

Responsible for Module:
Klaus Menrad (klaus.menrad@hswt.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

WZ1625: Environment Protection and Agricultural Ecosystems | Naturschutz und Agrarökosysteme

Version of module description: Gültig ab winterterm 2015/16

Module Level:	Language:	Duration:	Frequency:
Bachelor	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 Prüfungsleistung wird in Form einer Klausur erbracht. Im Rahmen dieser bearbeiten die Studierenden Verständnisfragen zu den in der Vorlesung behandelten Theorien und Ansätzen, erklären anhand von Fallbeispielen Wirkungszusammenhänge, Konflikpotenziale und Optimierungsmöglichkeiten der Anbausysteme. Grundlegende Begriffe müssen definiert und rechtliche Anforderungen benannten werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Mit dem Modul werden den Studierenden grundlegende Kenntnisse zu Agrarökosystemen und zum Naturschutz vermittelt. Ausgehend von Grundbegriffen der Ökologie werden die Ökosystemtheorie behandelt und Besonderheiten der Agrarökosysteme behandelt. Wechselwirkungen zwischen den Funktionen (Ökosystemleistungen) und der landwirtschaftlichen Produktionen (Konzept der Services and Disservices) sind wie die Umweltwirkungen der Landwirtschaft besondere Schwerpunkte. Dies stellt gleichzeitig den Übergang zum Themenbereich Naturschutzes dar, der zunächst definiert wird für den die wichtigsten Handlungsfelder (Schutzgüter, Eingriffe usw.) besprochen werden. Ausgehend vom Anbau Nachwachsender Rohstoffe werden sowohl Konfliktpotenziale als auch Chancen für den Naturschutz diskutiert. Dieser Bereich stellt einen Übergangsbereich zum Themenkomplex Umweltmanagement, Ökobilanzierung und Nachhaltigkeit dar.

Intended Learning Outcomes:
Nach dem Besuch des Moduls können die Studierenden Agrarökosysteme beschreiben und den Einfluss der Landwirtschaft charakterisieren. Sie haben das Konzept der Ökosytemleistungen verstanden und können „Services“ und „Disservices“ benennen. Anhand ausgewählter Beispiele können Sie Wirkungen des Anbaus auf die Ökosystemleistungen abschätzen und Effekte alternativer Anbauverfahren beschreiben. Die Studierenden wissen darüber hinaus welche Anforderungen des Naturschutzes an die Landwirtschaft gestellt werden und welche rechtlichen Rahmenbedingungen zu beachten sind. Sie sind in der Lage Anbausysteme bezgl. der Umweltwirkungen einzuschätzen und Empfehlungen zu Optimierung zu geben.

Teaching and Learning Methods:
Das Modul wird vorrangig als Vorlesung abgehalten. Einzelne Themenblöcke werden durch die Studenten eigenständig erarbeitet (Expertengruppen) und die Inhalte im Rahmen der Veranstaltung vorgestellt. Übungen anhand konkretrer Anbauszenarien dienen dazu, das theoretische Wissen anzuwenden und sich kritisch mit den Inhalten auseinanderzusetzen.

Media:
Vortrag, Präsentationen, (Einzel- und Gruppenarbeiten)

Reading List:
"Hampicke 2013: Kulturlandschaft und Naturschutz: Probleme-Konzepte-Ökonomie, Springer
Martin & Sauerborn 2006 : Agrarökologie, UTB, Stuttgart
Haber 2014: Landwirtschaft und Naturschutz, Wiley-VCH, Weinheim
Knauer 1993: Ökologie und Landwirtschaft, Ulmer, Stuttgart "

Responsible for Module:
Norman Siebrecht (norman.siebrecht@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

WZ1627: Agroforestry Systems / SRC | Agroforstsysteme / KUP

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**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:
Exam achievement shall be done in form of a written test in which the students are to economically assess agroforestry systems and short rotational plantations by analysing efficiency and in which they give answers to exam questions concerning definitions of different agroforestry systems and make calculations for carbon sink ability or erosion drainage. Different agroforestry systems with different specified conditions shall be illustrated in written form by using specific predefined application examples. For that purpose growing and harvesting techniques shall be mentioned correctly according to the example. Exam duration: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics of silviculture WZ 1607, Forestry and Wood WZ 1614, Basics of Plant Productioproperties n WZ 1604, Basics of Plant Growth, Knowledge of Trees and their Properties, Harvesting Techniques in the Forest and with Plant Production.

Content:
Significance and diffusion of agroforestry systems in Germany and internationally. Presentation of different agroforestry systems for producing renewable resources. Procedure for cultivation and use of agroforestry systems. Ecological impacts of agroforestry systems: Interactions between trees and agricultural usage systems, competitive relationships, CO2 reduction potentials, erosion control, biomass formation. Economic assessment. Management of short rotational plantations on agricultural areas, methods for evaluating biomass inventories, harvest of short rotational areas and agroforestry areas with different procedures. Consideration of growing and harvesting systems. Dangers arising from biotic and abiotic damage. Furthermore possible uses of products and difficulties resulting therefrom shall be imparted with solutions.

Intended Learning Outcomes:
The students are capable of recognising different agroforestry systems and in doing so assessing ecological and economic potentials of agroforestry systems and short rotational plantations for producing renewable resources. Besides it is possible for them to assess performances of agroforestry systems by the acquired knowledge and skills and to use concepts for site-typical agroforestry systems. The students are able to economically assess agroforestry systems by analysing efficiency for example. Furthermore they are able to classify use of existing products and identify both technical and economic best use.

Teaching and Learning Methods:
Lecture for imparting definitions, exercises. Study trip to testing areas including keynote speeches at the testing areas for which material research is necessary when the trip is prepared. Keynote presentations shall be prepared in small groups and encourage summarising of documents and train rhetorics. The study trip shall illustrate in practice what has been imparted theoretically up to now. Differently cultivated areas shall be compared by case studies as obviously big differences are to be seen in cultivation (profitable - not profitable with only small differences). Constructive criticism shall be trained.

Media:
Teaching materials in form of presentations, exercise examples and solutions; film, script, blackboard method, flipchart.

Reading List:
Current publications in scientific journals. Current studies. Reeg et. Al (2009), Anbau und Nutzung von Bäumen auf landwirtschaftlichen Flächen (Cultivation and Use of Trees on Agricultural Areas), published by: Wiley-VCH Verlag GmbH & Co. KGaA; edition: 1.
ISBN-10: 3527324178
ISBN-13: 978-3527324170;
Landgraf, Setzer (2012); Kurzumtriebsplantagen (Short Rotational Plantations: Holz vom Acker (Wood from the Field)
published by: DLG-Verlag
Language: German
ISBN-10: 3769020057
ISBN-13: 978-3769020052

Responsible for Module:
Alexander Höldrich (alexander.hoeldrich@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung
Agroforstsysteme / KUP
2 SWS

Übung

Agroforstsysteme / KUP
2 SWS

Alexander Höldrich (alexander.hoeldrich@tum.de)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1630: Special Topics in Organic Chemistry | Spezielle organische Chemie

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**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:
In a written test the students are able to show that they understand the applied chemical reactions and that they are able to reflect them in formula equation. The students show that they are able to reflect the different classes of natural products in formula screens. The students calculate typical reaction vessels without tools. Exam duration: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module of Basics of Chemistry (WZ No. 1602)

Content:
Petroleum and natural gas as primary source, crack and steam reforming reactions, technical olefin chemistry, technical aromatic chemistry, polyolefins, nitrogenous organic intermediates, organic carbon acids and other oxygen compounds as a preliminary stage of polyester production, organic chemical electrochemistry. Chemistry of carbohydrates

Intended Learning Outcomes:
After having successfully participated in the module the students areble to understand chemical reactions of petrochemical industry. They are able to represent product trees based on by- and co-products of reactions. Through this knowledge they are capable of classifying intermediate product chains towards finished plastic e.g. The students are able to understand typical reactions of different classes of organic substances.

Teaching and Learning Methods:
Lecture held by teaching staff including PP presentations, slides, books i.a. In addition a study trip to chemical industry plants in order to have typical industrial plants illustrated in space.

Media:
Presentations including powerpoint, blackboard method/lecture script

Reading List:
K. Weissermel, H.J.Arpe, Industrial Organic Chemistry, 4. Auflage, VCH Weinheim

Responsible for Module:
Herbert Riepl (herbert.riepl@hswt.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung
Spezielle organische Chemie
2 SWS
Vorlesung
Spezielle organische Chemie
2 SWS

Herbert Riepl (herbert.riepl@hswt.de)
Cordt Zollfrank (c.zollfrank@wz-straubing.de)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1631: Bioinformatics | Bioinformatik

Version of module description: Gültig ab winterterm 2023/24

Module Level:	Language:	Duration:	Frequency:
Bachelor	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:
Learning outcomes shall be verified in a written test (90 min). Tasks shall be specified by means of which the students are to demonstrate that they know the bioinformatic methods imparted as part of the module and that they have understood and are able to apply them for specific case studies.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
WZ1603/WZ1929 Biology
WZ1616/WZ1931 Biochemistry

Content:
Selected bioinformatic methods required for calculations in the scientific field, especially from the area of biological databases (e.g.NCBI, Swissprot), algorithms for sequence alignments (e.g. Needleman-Wunsch, Smith-Waterman, ClustalW, BLAST), phylogenetic reconstruction as well as methods from structural bioinformatics (e.g. Pymol, Docking). Methods shall be presented during the lecture. Within the scope of the exercise their application shall be practised based on specific case studies.

Intended Learning Outcomes:

Teaching and Learning Methods:
Lecture and associated exercise including independent processing of specific examples. The contents mediated by the lecture are outlined in the tutorial by means of concrete bioinformatic examples.The bioinformatic methods and algorithms which are presented in the lecture are proved and applied for concrete problems self-contained at the computer.

Media:
The lecture shall mainly be done by using powerpoint presentations. Introduction into bioinformatic software tools shall be done by using the corresponding internet pages. During the exercise the students work at PCs to independently implement skills learnt and gain confidence in working with the corresponding media and programmes.

Reading List:
Selzer, Marhöfer, Rohwer, 2008: Applied Bioinformatics, Springer Verlag

Responsible for Module:
Grimm, Dominik; 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

WZ1632: Basics of Renewables Utilization | Grundlagen der stofflichen Biomassenutzung

Version of module description: Gültig ab summerterm 2019

Module Level: Bachelor	**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:
Assessment takes a written examination (60 minutes), with students recall structure, transformation and use of different renewable resources. Students are required to answer questions using individual formulations and outline structures and reactions. In addition, sample calculations are to be worked out.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Introduction to various kinds of constituents of renewable resources: sugars, polysaccharides, fatty acids and oils, amino acids, proteins, terpenes, aromatics. Their structure, composition, distribution, characteristics, analytics and kind of added value, as well as their use will be introduced.

Intended Learning Outcomes:
After completion of the modules, students understand the chemical composition of renewable resources as well as their production and application. Using this knowledge students are able to explain the respective advantages and disadvantages as well as analyze the underlying physical, chemical and biotechnological principles of their conversion into valuable products.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations and case studies. Corresponding to the teaching content exercise sheets are

prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentation, script, examples and solutions

Reading List:
script, sample solutions for exercises

Responsible for Module:
Rühmann, Broder; 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

WZ1642: Project Management | Projektmanagement

Version of module description: Gültig ab winterterm 2013/14

Module Level: Bachelor	Language: German	Duration: one semester	Frequency: summer 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:
Achievement of desired learning objectives shall be verified in a written final exam. In addition there is teamwork where the contents learned shall be applied through planning and performing of projects. A 20 minutes' presentation shall be assessed according to aspects of content and rhetoric and be integrated into assessment by 50%. Exam duration: In writing (60 minutes), orally (20 minutes)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
WZ 1605 Betriebliche Ökonomie (Operational Economy), WZ 1622 Rechnungswesen und Controlling (Accounting and Controlling)

Content:
The lecture shall impart basics in project management. This includes: What are projects? What is project management? It deals with the approach of the project idea to result in performance and control including the five stages of a project: Analysis, definition, project order - planning, project structure plan, schedule - project realisation, project control - documentation and reporting. Furthermore methods and tools for performing a project shall be specified why projects fail, project management and team leadership.

Intended Learning Outcomes:
After attending the module the student will know basis of project management and project teamwork. They are able to process required and basic steps and necessary prerequisites for planning, performance or monitoring of projects. They reflect past own experiences and cope with possible problems of project work. They are able to develop a project design.

Teaching and Learning Methods:
'Teamwork with case studies, presentations

Media:
Presentations, slide scripts

Reading List:
SchulzWimmer, heinz: Projekte Managen (Managing Projects). Werkzeuge für effizientes Organisieren, Durchführen und Nachhalten von Projekten (Tools for Efficient Organisation, Performance and Follow-Up of Projects). Freiburg i. Breisgau 2002 - Litke, H.D.: Projektmanagement (Project Management): Methoden, Techniken und Verhaltensweiseisen (Methods, Techniques and Behaviours). München/Wien 1993

Responsible for Module:
Huber Röder (hubert.roeder@hswt.de)

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

Übung
Projektmanagement
1 SWS
Huber Röder
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1650: Introduction to Environmental and Resource Economics | Introduction to Environmental and Resource Economics

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. Type of examination: written, no additional tools allowed, duration of examination: 90 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Mikroökonomie, Makroökonomie

Content:
Environmental and natural resource economics is a rapidly growing and changing field as many environmental issues have become globally important. This course provides concepts such as sustainability (strong and weak) and economic growth, pollution as externality, policy measures for integrating negative external effects (cap and trade, subsidies, taxes, quotas), as well as methods for assessing the monetary value environmental goods and ecosystem services. Ideas that were once restricted to academic discussions are now part of the political mix.

Intended Learning Outcomes:
After participation students unterstand the role of the environment and natural resources in theory and practice of economics. Students are aware of the ways in which political decisions about the environment are made and why they often conflict with policy recommendations made by economists. It will make use of microeconomic analysis and will incorporate national and international examples. Students will be able to understand reasons and nature of market failure,

related externalities, benefit-cost analysis, market and nonmarket valuation techniques, and cost-effective policy instruments.

Teaching and Learning Methods:
The lecture as well as the tutorial take place by means of powerpoint. In Addition articles from newspapers and scientific journals will be integrated into the lectures. Based on the provided references, students will discuss concepts and derive hypotheses individually and/or groupwise from different perspectives of the current literature. For selected topics, classroom experiments will add up to this. Online lectures from international renowned experts and researchers will be integrated in the lecture.

Media:
Presentations, slide scripts, Articles, online lecture examples

Reading List:
Pearce, D. and R.K. Turner(1990). Economics of Natural Resources and the Environment. Johns Hopkins Univ Pr.
Tietenberg, T. and L. Lewis (2008). Environmental & Natural Resource Economics. Addison Wesley; 8 edition.

Responsible for Module:
Anja Faße (anja.fasse@hswt.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

WZ1652: Data Processing | EDV- Anwendung [EDP]

Version of module description: Gültig ab winterterm 2015/16

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

Numb

Media:
Presentations, slide scripts

Reading List:
Rolland F.D. Datenbanksysteme (Database Systems), 2003 Pearson

Responsible for Module:
Dominik Grimm (dominik.grimm@hswt.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Foundations of Programming (Exercise) (Übung, 2 SWS)
Grimm D [L], Eiglsperger J, Martello S

Foundations of Programming (Lecture) (Vorlesung, 2 SWS)
Grimm D [L], Grimm D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1654: Forest Management and Inventory | Forstmanagement und Waldinventur

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Exam achievement shall be done in the form of a written report. The students calculate the key performance indicators for forestal decisions and illustrate decision-making procedures and alternatives based on case studies. They show in the report that they are able to outline and explain forest management business processes. They demonstrate that they are able to answer problems on forest management and inventory in their own words. Exam achievement shall be completed by a presentation of the students for a specific and clearly defined topic. The report shall be weighted at a ratio of 30/70. Type of exam and exam duration: orally (20 minutes) or writing (60 minutes)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Forestry and Wood WZ 1614, Knowledge about Forestal Processes, Crop Establishment and Timber Harvest, Forest Growth (Basics of Silviculture WZ 1607).

Content:
The module aims at imparting to students in-depth knowledge of forest management. For that purpose it is necessary to explain forest logistics. As well management requirement from forestry such as: Timber trade, wood evaluation and business organisation as a tool for reaching the objective, selection of tree types and risk management in view of rotation period, management objective and climate change, optimisation of biological production using the example of dominant tree species in Bavaria as well as sale of wood as a central process towards products, services and corresponding sales markets. The module also aims at developing understanding of the most important principles, sustainable management of forests and forestry.

Besides knowledge for practical performance of inventories and use of equipment including commonly used measuring instruments (cruising rod, altimeter, Vertex, Suunto) shall be imparted. Finally inventories are part of the lecture including complete enumeration as well as characterisation of forest resources.

Intended Learning Outcomes:
After attending the module the student will be able to use contents of forest management. He will be able to understand management processes in a forest company and implement principles to determine wood sorting and marketing in view of rotation period and management objective for a forest company.
It is possible for him to take selection decisions in a logical and transparent way by including economic and ecological criteria and thus understand central management processes in a forest company. The conflict of forest and game shall be understood concerning its impacts relevant for forest management. The students understand the use of measuring instruments for forest management and harvest planning. They are able to compare assessment of wood production of forest resources for different variants of timber harvest and implement it in practice.

Teaching and Learning Methods:
Project work using case studies in cooperation with a regional forest enterprise and AELF, practice by teamwork in the forest, presentation

Media:
Expert lecture, powerpoint, exercise sheets, measuring instruments

Reading List:
T. Knoke, Forstbetriebsplanung (Forest Operational Planning), 2012, 408 pages, 125 black-and white illustrations, Dimensions: 17,7 x 23,7 cm, Paperback (TB), German
Hrsg. v. Thomas Knoke ULMER EUGEN ISBN-10: 3800176114
ISBN-13: 9783800176113
H. Kramer, A. Akca, 1995, Leitfaden zur Waldmesslehre (Guide for Forest Mensuration) published by: Sauerländer, J D; edition: 3rd expanded and improved ed.
Burschel, P. & Huss, J. 1987. Grundriss des Waldbaus (Ground Plan of Silviculture). Ein Leitfaden für Studium und Praxis (A Guide for Study d Practice). Parey, Hamburg und Berlin. 352 S.
Elverfeldt, Freiherr von A.
Rittershofer, F. 1999. Waldpflege und Waldbau (Forest Management and Silviculture). Für Studium und Praxis (For Study and Practice). Gisela Rittershofer Verlag, Freising. 492 p.

Responsible for Module:
Hubert Röder

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

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

Module Description

WZ1656: Electrical Engineering | Elektrische Energietechnik

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**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:
Exam achievement shall be done in the form of a written test. The students shall show that

electrical engineering to perform simple calculations relating to electrical engineering and energy technology. Furthermore the students are aware of different possibilities of energy conversion within the scope of electrical energy technology.

Teaching and Learning Methods:
The module consists of one lecture and an associated session of exercises. Contents of the lecture shall be imparted in a speech and deepened through independent preparation of exercises by the students. The finished exercises shall be discussed in the associated session of exercises.

Media:
Presentations, slide scripts, writing on the board

Reading List:
Fischer, R.; Linse, H. (2012): Elektrotechnik für Maschinenbauer (Electrical Engineering for Mechanical Engineers), 14th edition, ISBN: 978-3-8348-1374-9;
Klaus Heuck, Elektrische Energieversorgung (Electrical Energy Supply), 2010, Vieweg Teubner;
Panos Konstantin, Praxisbuch Energiewirtschaft (Practice Book of Energy Industry), 2009, Springer;
Horst Czichos (Hrsg.),
Hütte - Das Ingenieurwissen (Engineering Knowledge) , 2008, Springer;
Richard Zahoransky (Hrsg.), Energietechnik (Energy Technology), 2013, Springer Vieweg

Responsible for Module:
Josef Kainz (josef.kainz@hswt.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

WZ1660: Typesetting with LaTeX and Alternatives | Schriftsatz mit LaTeX und Alternativen [SchrisaLaAlt]

Good typesetting practices for scientific publications

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor	**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:
Exam achievement shall be done in the form of a written test (45 minutes). No tools are allowed.

Repeat Examination:

(Recommended) Prerequisites:
Basic IT skills

Content:
The module of typesetting with LaTeX and alternatives shall impart knowledge about the most important programmes for creation of written works by machine. After discussing general requirements for issuance of such a programme criteria for good typesetting shall be explained first. For that purpose it is already dealt with the individual prior knowledge and requirements of course participants. Different text processing programmes such as MS Word, Libre-/OpenOffice Writer, Abiword or Lotus Symphony may be treated e.g. Subsequently individual aspects of good typesetting will be implemented in a sample document. For that purpose comparison of used programmes constitutes an important didactic element. Comprehensively and within different programmes expedient and chronological approaches for creating a document will be discussed for that purpose. Also practicality in typical collaborative workflows will be discussed. Finally in-depth elements such as creating and integrating vector graphics and complex diagrams as well as calculation and integration of graphs will be treated. For that purpose search for solutions in the internet is an important element.

Intended Learning Outcomes:
After successfully completing the module the students are capable of selecting the typesetting programme suitable for their purpose. They are able to select the suitable support programmes and set up a strategy for document composition. Moreover they know limits and compatibilities of the respective programmes in the workflows and are able to proactively plan their documents to face all eventualities of collaborative and individual work.

Teaching and Learning Methods:
Speech, demonstration, practical performance in IT room

Media:
Writing on the board, demonstration, own workplace L paT

Reading List:
https://de.wikibooks.org/wiki/LaTeX-Kompendium
Schlosser J. Wissenschaftliche Arbeiten schreiben mit LaTeX: Leitf□L

Module Description

WZ1664: Energy Storage | Energy Storage

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 examination is a 90-minute written final exam. Students prove in exercices their ability to perform the laying-up of energy storage systems and to calculate their specifications and properties. Furthermore the general understanding of different storage technologies and their specific characteristics is tested. The only aid allowed is a handheld calculator.
A term paper is a requirement for the final exam but is not part of the final grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Technical Thermodynamic, basic but profound knowledge in physics

Content:
The course energy storage gives an overview of established storage systems as well as those being under way. The setup and operation mode of different kinds of energy storage (thermal, mechanical, chemical, electrical and eletrochemical) as well as their application and integration is presented. The status quo of technology and the potential for improvement is depicted.

Intended Learning Outcomes:
The course enables the students to fully understand the complex structures involved in energy storage. They know about different storage types and concepts for heat and electricity. Characterisation on the basis of technical and economic figures is possible.

Teaching and Learning Methods:
The module consists of a lecture course with integrated practical elements. The lecture's content are mediated by the instructor's presentation and exercise examples. By solving given tasks at

home and if necessary students presentations the acquired knowledge is consodiated. The writing of the term paper is also a means of consolidation.

Media:
Powerpoint, whiteboard, exercise sheets

Reading List:
Sterner, M.; Stadler, I.: Energiespeicher, Springer Vieweg, ISBN 978-3-642-37379-4, 2014
Rummich, E.: Energiespeicher, expert-Verlag,
ISBN: 978-3-8169-3297-0, 2015
Karl, J.: Dezentrale Energiesysteme, Oldenbourg,
ISBN 3-486-27505-4, 2004

Responsible for Module:
Matthias Gaderer

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

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

Module Description

WZ1680: General and Inorganic Chemistry | Grundlagen allgemeine und anorganische Chemie [Chem]

Version of module description: Gültig ab winterterm 2015/16

Module Level:	**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 performance test will be in the form of a written examination rendered. The students should demonstrate in the exam the understanding of the structure of chemical compounds and their typical reactions and chemical conversions. It will also be tested the ability to formulate reaction equations, calculate reaction kinetic and thermodynamic parameters, as well as to transfer the acquired knowledge about the structure and reaction behavior of chemical substance groups to new chemical questions. No auxiliary means are allowed in the exam. 120 min examination time

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of chemistry, mathematics and physics, which correspond to the basic course knowledge of the gymnasiale upper school

Content:
General principles of inorganic and physical chemistry: Atomic and molecular construction, structure of compounds, acid / base equilibria, redox reactions, thermodynamics,reaction kinetics and catalysis, fundaments on electrochemistry, selected reactions of inorganic chemistry

Intended Learning Outcomes:
The students will know and understand the basic principles of chemical reactions and will be able to formulate correct reaction equations and simple reaction kinetic and thermodynamic calculations. Moreover, they will be able to apply the knowledge acquired with model reactions about chemical transformations of chemical substances and substance groups to answer new chemical questions. The students will also get familiar with the practical work in chemical

laboratories. The successful participation in the module will enable the students to participate in the module of basic organic chemistry.

Teaching and Learning Methods:
Lectures and corresponding exercises with self analysis and workup of specific case studies; Selected, related experiments in the chemical laboratory

Media:
Blackboard, presentation (using script), exercises, laboratory equipment.

Reading List:
1) Theodore L., H. Eugene LeMay, Bruce E. Bursten, Chemie Studieren Kompakt, 10. aktualisierte Auflage, Pearson Verlag, München; 2) Charles E. Mortimer, Ulrich Müller, Chemie, 10., überarbeite Auflage, Thieme Verlag, Stuttgart

Responsible for Module:
Herbert Riepl herbert.riepl@hswt.de

Courses (Type of course, Weekly hours per semester), Instructor:
Allgemeine und anorganische Chemie / Angleichung Chemie (Vorlesung) (Vorlesung, 2 SWS)
Riepl H [L], Riepl H

Allgemeine und anorganische Chemie (Übung) (Übung, 2 SWS)
Riepl H [L], Riepl H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1681: Organic Chemistry | Organische Chemie [OC]

Version of module description: Gültig ab winterterm 2015/16

Module Level:	Language: German	Duration: one semester	Frequency: summer 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 performance test will be in the form of a written examination rendered. The students should demonstrate in the exam the understanding of the structure of organic chemical compounds and their typical reactions and chemical conversions. It will also be tested the ability to formulate reaction equations, as well as to transfer the acquired knowledge about the structure and reaction behavior of organic chemical substance groups to new chemical questions. No auxiliary means are allowed in the exam. 120 min examination time

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
General principles of organic chemistry:
Structure of organic compounds, carbon-atom hybridization, important functional groups, nomenclature and structure of organic molecules, selected reactions of organic chemistry for important groups of substances including central natural substances (e.g. carbohydrates, peptides, etc)

Intended Learning Outcomes:
The students will know and understand the basic principles of organic chemical reactions and will be able to formulate correct organic reactions. Moreover, they will be able to apply the knowledge acquired with model reactions about chemical transformations of organic chemical substances and substance groups to answer new chemical questions. The students will also get familiar with the practical work in organic chemical laboratories. The successful participation in the module will

also enable the students to participate in the advanced modules for special organic chemistry and polymer chemistry, as well as the focused modules on biochemistry and cell and molecular biology

Teaching and Learning Methods:
Lectures and corresponding exercises with self analysis and workup of specific case studies; Selected, related experiments in the chemical laboratory

Media:
Blackboard, presentation (using script), exercises, laboratory equipment.

Reading List:
K.P.C. Vollhardt, N.E. Schorle, Organische Chemie, Verlag VCH Weinheim

Responsible for Module:
Cordt Zollfrank (cordt.zollfrank@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung
Organische Chemie
1,5 SWS
Übung
Organische Chemie
0,5 SWS
Praktikum
Organische Chemie
2 SWS
Cordt Zollfrank (cordt.zollfrank@tum.de)
Herbert Riepl (herbert.riepl@hswt.de)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1682: Basics Economy | Betriebliche Ökonomie

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**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:
In the written examination (60 minutes) students demonstrate by answering questions (in writing/ graphically) without helping material the theoretical knowledge of profit-orientated business ventures. In addition, it is checked whether students can make well-founded assessments of business processes under time pressure.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
WZ 1683 Economics

Content:
In "business economics" module the basic concepts of the different business disciplines are reviewed in order to provide students a basic economic literacy. In particular, economic issues relating renewable natural resources are discussed in general and through case studies.
1. Introduction: The company as the subject of Business Administration, typology of the company, corporate objectives;
2. Organization & Management: organizational forms and theoretical approaches;
3. Financing: Basic financial concepts, financial planning and control, types of financing;
4. Investment: investment appraisal, business valuation;
5. Human Resources: recruitment, staffing, staff development;
6. Production and materials management;
7. Accounting: Fundamentals of external and internal accounting;
8. Marketing: Basics of market research and product policy.

Intended Learning Outcomes:
Upon successful completion of this module, students are able to recognize the special features and interdependency of the disciplines of business economy. In addition, students are able to apply the presented concepts to the area of renewable natural resources and to understand the importance of economic policy decisions regarding the NawaRo industry (industry of natural renewable resources).

Teaching and Learning Methods:
The module is divided into a lecture and an exercise. The lecture is designed as interactive frontal teaching. This teaching method enables the lecturer to discuss a large number of topics in this introductory course. As part of the exercise students solve problem sets in individual or group work, the solutions will be presented by the students during the exercise. Memorizing definitions can provide the intended economic literacy. Group work is aimed to apply the topics to problem sets and to promote teamwork.

Media:
PowerPoint, script, whiteboard, exercise sheets;

Reading List:
Einführung in die Allgemeine Betriebswirtschaftslehre, Wöhe/Döring, Vahlen, 24. Auflage; Grundzüge der Betriebswirtschaftslehre, Schierenbeck, Oldenbourg Wissenschaftsverlag, 16. Auflage; Allgemeine Betriebswirtschaftslehre, Hutschenreuter, Gabler Verlag, 4. Auflage; BWL für Ingenieure, Junge, Gabler Verlag, 1. Auflage; Allgemeine Betriebswirtschaftslehre, Thommen/Achleitner, Gabler Verlag, 6. Auflage;

Responsible for Module:
Röder, Hubert; 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

WZ1683: Economics | Volkswirtschaft

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**Language:**	**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 examination (60 minutes) students demonstrate by answering questions (in writing/graphically) without helping material the theoretical knowledge of economics. In addition, it is checked whether students can make well-founded assessments of current economic policy issues under time pressure.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Business Economics

Content:
The module "Economics" is a brief introduction to micro- and macroeconomic theories. Moreover economic policy measures related to the renewable resources are presented and discussed.
1. Principles of economics: concepts, classification in the social sciences;
2. Introduction to microeconomics: Derivation of supply and demand, market equilibrium, market intervention and its impact, producer and consumer surplus;
3. Political interventions in the market: Theoretical foundations of CO2 certificate trading, EEG, environmental control;
4. Introduction to Macroeconomics: measurement of national income, growth and production, financial system, monetary system.

Intended Learning Outcomes:
Upon successful completion of this module, students are able to understand the relation of supply and demand and to recognize the relevance of economic elasticities. In particular, students are able to apply the presented reasons for market failure to the area of renewable natural resources

and to understand the importance of economic policy decisions on the NawaRo industry (industry of natural renewable resources).

Teaching and Learning Methods:
The module is divided into a lecture and an exercise. The lecture is designed as interactive frontal teaching. This teaching method enables the lecturer to discuss a large number of topics in this introductory course. As part of the exercise students solve problem sets in individual or group work, the solutions will be presented by the students during the exercise. In addition, a group discussion is provided to a current economic topic in exercise. To take an active part in the discussion, it is required that students read preselected literature and search for reference materials. Group work is aimed to apply the topics to problem sets and to promote teamwork.

Media:
PowerPoint, script, whiteboard, exercise sheets, reader;

Reading List:
Mankiw, N. (2012), Grundzüge der Volkswirtschaftslehre, Schäffer-Poeschel Verlag, Stuttgart; Krugman, P. und Wells, R. (2010), Volkswirtschaftslehre, Schäffer-Poeschl Verlag, Stuttgart; Endres, A. (2013) Umweltökonomie, Verlag W. Kohlhammer, Stuttgart; Endres, A. und Querner, I. (2000), Die Ökonomie natürlicher Ressourcen, Verlag W. Kohlhammer, Stuttgart.

Responsible for Module:
Anja Faße (anja.fasse@hswt.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Economics I am Campus Straubing (Microeconomics) (Vorlesung, 2 SWS)
Goerg S [L], Goerg S

Economics I - Übung am Campus Straubing (Übung, 2 SWS)
Goerg S [L], Speckner M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1687: Introduction to Medicinal and Spice Plants | Einführung in die Heil- und Gewürzpflanzen [MSP]

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** summer 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:
In an written exam the students shall demonstrate that they recognize the most important medical and spice plants from the European area. They shall demonstrate that they are able to explain cultivation methods as well as harvest and drying. They shall be able to represent the ingredients of medical and spice plants and medical effect by using examples. Type of exam: written, Exam Duration: 60 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Organic and Inorganic Chemistry, Botanics, Plant Production

Content:
Medicinal herbs history, presenting medical and spice plants, setting up of a herbarium, aspects of plant production for creating herb fields, their crop protection and harvest. Techniques for herb drying. Classes of agents such as terpenes, steroids, coumarins, alkaloids, vitamins, flavonoids. Connection between classes of agents and their medical effect. Basic mechanism of action of different classes of agents. Typical medicinal plants from European cultivated areas. Modern cultivation and use of medicinal plants in practice.

Intended Learning Outcomes:
After having participated in the module units the students are able to recognize medical and spice plants. They know basis of plant production for setting up a spice garden or fields. They know process technology basics for spice drying. They are able to designate the most important classes of agents. The students are able to call up connection between medical effect and chemical classes of agents by using typical examples. By having participated in the exercises in the spice

garden and laboratory work they are able to use simple analytical-chemical activities relating to plant analysis or assess their results.

Teaching and Learning Methods:
Lecture, speech by teaching staff by using PP media, books and other written material, setting up of a herbarium, study trip to a herb drying company. Exercise (e.g. Experimentation of students under supervision). Excursion on research fields (LfL) in Manching. Determine Herbs in a garden.

Media:
PP presentations and printed versions as documents. Laboratory equipment for experimentation, ready-made exercise analyses. Herbs for a determination and view on etheric oils.

Reading List:
Deutschmann, F., Hohmann, B., Sprecher, E., Stahl, E., Pharmazeutische Biologie (Pharmaceutical Biology), 3 volumes, G. Fischer Verlag, 1992
Wendelberger, E., Heilpflanzen (Medicinal Plants): Erkennen | Sammeln | Anwenden (Recognising | Collecting | Using) (paperback – BLV Buchverlag Januar 2013

Responsible for Module:
Corinna Urmann (alexander.hoeldrich@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

WZ1691: Heat and Mass Transfer, Fluid Dynamics, Particle Technolgy | Wärme-, Stoff-, Strömungs- und Partikellehre

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**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:
Exam achievement shall be done in the form of a written test. The students calculate thermotechnical and fluidic tasks. They are able to explain dimensionless quantities and apply them in arithmetic examples, explain and calculate different mechanisms of heat transfer and material transport and explain processes on porous particles. Type of exam: In writing, Exam duration: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of the most important physical correlations (basic parameters with units, definition of pressure, temperature, enthalpy, entropy etc.) must be available. Besides formation and solution of systems of equations as well as command of simple integral and differential calculus is a requirement.
Physics WZ1600, Mathematics WZ1601
Thermodynamics and Thermal Engineering TDW

Content:
In this module knowledge in heat transfer gained from the lecture of thermodynamics and thermal engineering (TDW) shall be extended, fluidic basics and material transport mechanisms shall be explained, similarity of processes shall be discussed and dimensionless quantities deduced. Application of what was learned shall be done based on examples as part of the lecture. Thus particle, packed bed, fluidized bed and entrained-flow reactors shall be explained e.g.

Intended Learning Outcomes:
After having participated in the module the students are capable of understanding and analysing simple tasks relating to heat transfer (convection, conduction, radiation), flow (e.g. flow resistance) and mass transfer, of applying methods to solve the tasks and of performing a mathematical solution.

Teaching and Learning Methods:
The module consists of a lecture during which also exercises will be performed alternately. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and have a critical look at the topics. In the exercises performed as part of the lecture learned theory shall directly be applied with a practical orientation.

Media:
Presentations, slide scripts, exercises

Reading List:
[224] Stephan, P.; Schaber, K.; Stephan, K.; Mayinger, F.: Thermodynamik (Thermodynamics), volume 1: Einstoffsysteme (Single-Component Systems), 17th edition, Springer, ISBN 978-3-540-70813, 2006
[226] Baehr, Hans Dieter; Kabelac, Stephan: Thermodynamik (Thermodynamics), 14th edition, Springer, ISBN 978-3-642-00555-8, 2009
[] Wärme- und Stoffübertragung (Heat and Mass Transfer), Hans Dieter Baehr und Karl Stephan, Springer, ISBN 978-3-642-36558-4 , 2013
[227] HSC Chemistry, Outokumpu Research Oy, Pori, Finnland, A. Roine, Ver. 1.10, 1990
[233] Stephan, P.; Schaber, K.; Stephan, K.; Mayinger, F.: Thermodynamik Grundlagen und technische Anwendungen (Thermodynamics - Basics and Technical Applications), volume 2: Mehrstoffsysteme und chemische Reaktionen (Multi-Compound Systems), 15th edition, Springer, ISBN 978-3-540-36709-3, 2010
[234] Gmehlin, J.; Kolbe, B.: Thermodynamik (Thermodynamics), 2nd edition, VCH, ISBN 3-527-28547-4, 1992
[235] Atkins, Peter W.: Grundlagen der Stoff- und Energiebilanzierung (Basics of Material and Energy Balancing), 9th edition, Vieweg, ISBN 3-527-25913-9, 1990
[268] GTT-Technologies; Programm Factsage 6.3, http://www.gtt-technologies.de)
[242] VDI Wärmeatlas (VDI Heat Atlas), VDI-Gesellschaft Verfahrenstechnik und Chemie-Ingenieurwesen (Association of German Engineers - Process Engineering and Chemical Engineering) 9th edition, Springer-Verlag ISBN 3-540-41201-8 9th edition

Responsible for Module:
Matthias Gaderer (gaderer@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

WZ1693: Bachelor's Thesis | Bachelor's Thesis

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**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 module is completed with the preparation and positive evaluation of the Bachelor´s Thesis (depending on selection of topics 10 to 25 pages).

Repeat Examination:

(Recommended) Prerequisites:
120 credits, including all compulsory modules from the first four semesters, according to the module plan of the respective bachelor's program

Content:
consolidation of the knowledge of a specific topic in the area of Renewable Ressources which is arbitrary in consultation with the supervisor / consolidation of practical skills in the lab / presentation of a research-based topic in the field of Renewable Ressources

Intended Learning Outcomes:
After completion of the module, the students are able to work self-reliant on simple scientific problems on the basis of scientific methods and analytical thinking. The can present their results in a conclusive way, are able to discuss and to draw conclusions.

Teaching and Learning Methods:
During the Bachelor´s Thesis, the students work on a scientific problem. At this juncture amongst others literature research as well as lab work and presentations are used. The actual teaching and learning methods depend on the respective problem and have to be discussed with the supervisor for each single case.

Media:
Specialist literature, software and so on

Reading List:
in consultation with the supervisor

Responsible for Module:
Volker Sieber sieber@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

WZ1922: General Chemistry | Allgemeine Chemie [Chem]

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**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 performance test will be in the form of a written examination rendered. The students should demonstrate in the exam the understanding of the structure of chemical compounds and their typical reactions and chemical conversions. It will also be tested the ability to formulate reaction equations, calculate reaction kinetic and thermodynamic parameters, as well as to transfer the acquired knowledge about the structure and reaction behavior of chemical substance groups to new chemical questions. No auxiliary means are allowed in the exam. 90 min examination time

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of chemistry, mathematics and physics, which correspond to the basic course knowledge of the gymnasiale upper school

Content:
General principles of inorganic and physical chemistry: Atomic and molecular construction, structure of compounds, acid / base equilibria, redox reactions, thermodynamics, reaction kinetics and catalysis, fundaments on electrochemistry, selected reactions of inorganic chemistry

Intended Learning Outcomes:
The students will know and understand the basic principles of chemical reactions and will be able to formulate correct reaction equations and simple reaction kinetic and thermodynamic calculations. Moreover, they will be able to apply the knowledge acquired with model reactions about chemical transformations of chemical substances and substance groups to answer new chemical questions. The successful participation in the module will enable the students to participate in the module of basic organic chemistry.

Teaching and Learning Methods:
Lectures and corresponding exercises with self-analysis and workup of specific case studies. In relation to the teaching content exercise sheets are disbursed on which the students work in self-study before the tutorials. The solution and discussion takes place in the tutorials. At the postprocessing of the lecture exspecially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the structure and reaction behavior of chemical substance groups and practise the formulation of reaction equations.

Media:
Blackboard, presentation (using script), exercises.

Reading List:
1) Theodore L., H. Eugene LeMay, Bruce E. Bursten, Chemie Studieren Kompakt, 10. aktualisierte Auflage, Pearson Verlag, München;
2) Charles E. Mortimer, Ulrich Müller, Chemie, 10., überarbeite Auflage, Thieme Verlag, Stuttgart

Responsible for Module:
Riepl, Herbert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Allgemeine und anorganische Chemie / Angleichung Chemie (Vorlesung) (Vorlesung, 2 SWS)
Riepl H [L], Riepl H

Allgemeine und anorganische Chemie (Übung) (Übung, 2 SWS)
Riepl H [L], Riepl H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1923: Physical Chemistry | Physikalische Chemie [PhysChem]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	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 learning results are going to be proved in form of a written test (120 min). The students solve physical/chemical arithmetic problems and answer questions for definitions or physical/chemical relations. They prove that they have understood the basic relations of physical chemistry that are highlighted within the scope of the module and can use the systems of equations. Calculators are allowed additives. Other additives can be permitted by the lecturer as needed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
A-level student knowledge of mathematics (especially differentiation and integration) and physics

Content:
Basics of chemical thermodynamics: laws of thermodynamics, forms of energy (U, H, G, S), relations of formulas; chemical equilibrium and chemical reactions; properties of gases; phase transition of pure substances and multiphase systems; two component systems; selected boundary surface phenomena; basics of reaction kinetics

Intended Learning Outcomes:
After successful completion of the module the students know the laws of thermodynamics; they are able to make calculations concerning U, H, S and G; they understand phase diagrams of one and two component systems, can create charts and calculate the condition of equilibrium of simple systems; they can calculate with partial molar quantities in multi component systems; they can use ideal and real gas equations; they are able to form and solve equations related to the kinetics of chemical reactions and to determine the order of reactions;

Teaching and Learning Methods:
Teaching methods: in the lecture the teaching content is communicated by a talk of the lecturer, supported by PowerPoint and sketches on the blackboard in which the latter form is chosen to derivate complex relations. To a limited extent this can be completed for selected topics by self-study of the textbook by the students. In relation to the teaching content exercise sheets are disbursed on which the students work in self-study before the tutorials. The solution and discussion takes place in the tutorials. Learning methods: at the postprocessing of the lecture especially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the physical-chemical relations and practise the usage of the systems of equations.

Media:
PowerPoint, whiteboard, exercise sheets, textbook, optional: script

Reading List:
Lehrbuch: P.W. Atkins, J. de Paula, Physikalische Chemie, 5. Auflage, Wiley-VCH, 2013

Responsible for Module:
Schieder, Doris; 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

WZ1924: Basic Organic Chemistry | Grundlagen Organische Chemie [OrgChem]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 performance test will be in the form of a written examination rendered. The students should demonstrate in the exam the understanding of the structure of organic chemical compounds and their typical reactions and chemical conversions. It will also be tested the ability to formulate reaction equations, as well as to transfer the acquired knowledge about the structure and reaction behavior of organic chemical substance groups to new chemical questions. No auxiliary means are allowed in the exam. 90 min examination time

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge of chemistry, mathematics and physics, which correspond to the basic course knowledge of the gymnasiale upper school

Content:
General principles of organic chemistry:
Structure of organic compounds, carbon-atom hybridization, important functional groups, nomenclature and structure of organic molecules, selected reactions of organic chemistry for important groups of substances including central natural substances.

Intended Learning Outcomes:
The students will know and understand the basic principles of organic chemical reactions and will be able to formulate correct organic reactions. Moreover, they will be able to apply the knowledge acquired with model reactions about chemical transformations of organic chemical substances and substance groups to answer new chemical questions.The successful participation in the module

will also enable the students to participate in the practical course and the module advanced organic chemistry.

Teaching and Learning Methods:
Lectures and corresponding exercises with self analysis and workup of specific case studies. In relation to the teaching content exercise sheets are disbursed on which the students work in self-study before the tutorials. The solution and discussion takes place in the tutorials. At the postprocessing of the lecture exspecially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the structure and reaction behavior of organic chemical substance groups and practise the formulation of reaction equations.

Media:
Blackboard, presentation (using script), exercises

Reading List:
K.P.C. Vollhardt, N.E. Schore, Organische Chemie, Verlag VCH Weinheim

Responsible for Module:
Prof. Nicolas Plumeré Dr. Alaa Alsheikh Oughli

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

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

Module Description

WZ1925: Practical Course General Chemistry | Praktikum Allgemeine Chemie [Chem]

Version of module description: Gültig ab winterterm 2022/23

Module Level: Bachelor	**Language:** German/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:
Perfomance is going to be effected by a protocol in the form of the lab journal. For each lab experiment, two handwritten pages containing experimental procedure and analysis should be prepared. Therein students should prove their understanding of the structure of chemical compounds and aggregation states. In addition, they should show that they understand chemical reactions and their thermodynamic and kinetic aspects. Furthermore, the students should show that they are able to use lab instruments and equipment correctly for chemical experiments.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge of chemistry, mathematics and physics, which correspond to the basic course knowledge of the gymnasiale upper school

Content:
General principles of inorganic and physical chemistry and experimental essays: Structure of compounds, acid / base equilibria, redox reactions, thermodynamics, reaction kinetics, selected reactions of inorganic chemistry.

Intended Learning Outcomes:
The students will know and understand chemical structures, aggregation states of compounds and the basic principles of chemical reactions. The students will get familiar with the practical work in chemical laboratories. They will be able to perform and formulate correctly chemical reactions, and experimentally determine thermodynamic and kinetic aspects of chemical reactions. The successful participation in the module will enable the students to participate in the module of basic organic chemistry

Teaching and Learning Methods:
Laboratory experiments and equipment.

Media:
Laboratory equipment.

Reading List:
1) Practical Labor Script; 2) Theodore L., H. Eugene LeMay, Bruce E. Bursten, Chemie Studieren Kompakt, 10. aktualisierte Auflage, Pearson Verlag, München;

Responsible for Module:
Prof. Rubén Costa

Courses (Type of course, Weekly hours per semester), Instructor:
Labor-Praktikum Allgemeine und anorganische Chemie (Praktikum, 5 SWS)
Costa Riquelme R [L], Asin Vicente A, Atoini Y, Englberger H, Jaschik L, Maidl M, Mauz A, Nieddu M, Schieder D, Wolf P
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1926: Practical Course Basic Organic Chemistry | Praktikum Grundlagen Organische Chemie [POC]

Versio

Teaching and Learning Methods:
By own guided experimentation of students, use of chemicals and typical equipment is trained. Hereby manual skill and successful experimentation handicraft is obtained. About 10 experiments are conducted.

Media:
student teaching laboratory

Reading List:
H.G. Becker, Organikum, 21. Aufl., Wiley VCH

Responsible for Module:
Riepl, Herbert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum
Organisch chemisches Praktikum
6 SWS
Herbert Riepl
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1927: Instrumental Analysis and Spectroscopy | Instrumentelle Analytik und Spektroskopie

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 135	**Contact Hours:** 105

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 with 90min duration and serves to check the knowledge of the theoretical basics of all treated analytical methods, since only an excerpt of these methods is applied in the seminar part.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
In the module the basics of instrumental analysis are communicated. Thereby particular physicochemical characterization methods, basic principles of measurement and the setting of analysis instruments are disscussed in detail. In detail are these: optic/electricl/magnetic measuremnts, adsorption/desorption as basis for chromatopraphic techniques, adsorption/desorption related to vibrational spectroscopy and UV/Vis spectroscopy, nuclear resonance spectroscopy, mass determination and spectrometry, scatter methods, atomic spectroscopy and gas and high performance liquid chromatography. The handling of the received measuring results is explained by case studies.

Intended Learning Outcomes:
After visiting the required modul the students are able to select corresponding physicochemical analysis methods for underlying practical problems and to use these methods as needed. On the basis of the gained knowledge the students can analyse the obtained measuring results in a competent way.

Teaching and Learning Methods:
The theoretical basics of the experiments conducted in the practical course will be delivered in the lecture part via ppt-presentations, movies and white board. In the practical course, the students will self-reliantly perform, document and analyse their experiments.

Media:
presentation, script, cases and solutions lab and equipment

Reading List:
script, sample solutions for the exercises

Responsible for Module:
Zollfrank, Cordt; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Instrumentelle Analytik und Spektroskopie (Seminar) (Übung, 4 SWS)
Rühmann B [L], Riepl H, Rühmann B, Urmann C, Zieleniewska A

Instrumentelle Analytik und Spektroskopie (Vorlesung) (Vorlesung, 3 SWS)
Rühmann B [L], Riepl H, Rühmann B, Urmann C, Zieleniewska A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1928: Advanced Organic Chemistry | Organische Chemie für Fortgeschrittene [AOC]

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	[illegible]		

in self-study before the tutorials. The solution and discussion takes place in the tutorials. At the postprocessing of the lecture especially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the chemical reactions of our fossil based chemical production and practise the presentation of product trees.

Media:
Powerpoint presentations, whiteboard, printed text of teaching

Reading List:
K. Weissermel, H.J.Arpe, Industrial Organic Chemistry, 4. Auflage, VCH Weinheim

Responsible for Module:
Riepl, Herbert; 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

WZ1929: Cell Biology and Microbiology | Zell- und Mikrobiologie [MiBi]

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**To**		

informations and of the most important metabolic pathways and can grade bacteria, fungi and plants to higher-ranking systematic groups. After completion of the module the participants know differe

Module Description

WZ1930: Practical Course Microbiology | Praktikum Mikrobiologie

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 105	**Contact Hours:** 75

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

Description of Examination Method:
The performance is effected by written protocols of the executed laboratory experiments ((for each experiment about 5 pages of protocol). With these protocols the students prove that they are able to unterstand the theoretical background of the experiments, to report their experimental procedure and to evaluate their results. Furthermore, they should show that they can discuss deviations of the expected results and possible reasons.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Module Cell and Microbiology

Content:
Microscopy, methods of colony isolation, colony count, differentiation of bacteria, isolation of microorganisms, identification methods for microorganisms, bacteriophages, growth behaviour of microorganisms

Intended Learning Outcomes:
After module participation the students are familiar with the execution of experiments in microbiological labs and able to use the mediated microbiological working techniques at least in main features. They handle aseptic techniques and can identify microorganisms. In addition, they possess a deeper understanding of the theories which underlie the experiments. Furthermore, the students can report laboratory experiments in a correct way and evaluate and analyse them by means of the theoretical backgrounds under guidance.

Teaching and Learning Methods:
Laboratory experiments in small groups (approx. 10 experiments) under guidance with previous introduction of the theory related to the particular experiments (lecture) as well as analysis of the results by experiment reports. Aspects related to safety issues in the laboratory are also covered in the lectures.

Media:
Practical course script

Reading List:
Practical course script

Responsible for Module:
Erich Glawischnig (egl@wzw.tum.de)

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

Praktikum
Mikrobiologisches Praktikum
4 SWS
Erich Glawischnig
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1931: Biochemistry | Biochemie [BC]

Version of module description: Gültig ab winterterm 2022/23

Module Level: Bachelor	**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 learning results are proved in form of a written test (90 min exam duration). Based on questions to biochemical metabolic pathways and enzymology the students prove that they know the corresponding technical terms, designations and contents, that they have understand the basic relations and are able to apply their knowledge concerning the reactions taking place within the scope of kinetic and thermodynamic connections. For that purpose concrete computational tasks are assigned.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the modules "Basic Organic Chemistry", "General Chemistry" and "Cell and Microbiology".

Content:
Enzymology: Within the module the students shall be introduced into basics of enzyme catalysis. In doing so theories relating to the course of enzymatic reactions, special aspects of kinetics and thermodynamics of enzyme-catalysed reactions, inhibition mechanisms as well as possibilities for calculating kinetic parameters shall be treated inter alia. Metabolism: Basic metabolic pathways such as glycolysis, citrate-cycle or gluconeogenesis shall be presented in the lecture. In doing so it is dealt with the general course of reaction cascades, thermodynamic aspects of energy generation as well as mechanisms of modulation of the individual paths.

Intended Learning Outcomes:
After sucessful completion of the module the students are able to describe and explain basic concepts, phenomenons and relations in the field of biochemistry. The students know important properties of proteins,understand the significance of kinetic parameters of enzymatic reactions

and will be able to calculate them and apply to new issues (e.g. inhibition). Furthermore the students will be able to specify in detail basic metabolic pathways of the most important classes of substances, understand the particular steps and regulation systems of the respective paths.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations and blackboard sketches. Corresponding to the teaching content exercise sheets are prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentations, powerpoint, presentation script, exercise sheets

Reading List:
- Voet, D. , Voet, J.G., Biochemistry 4th Edition, Wiley-VCH, 2011;
- Nelson, D.L, Cox, M.M., Lehninger Principles of Biochemistry 5th Edition, WH Freeman, 2008;
- Berg, J.M, Tymoczko, J.L., Stryer, L., Biochemistry 6th Edition, 2006

Responsible for Module:
Dr.-Ing. Ammar Al-Shameri

Courses (Type of course, Weekly hours per semester), Instructor:
Biochemie (Vorlesung) (Vorlesung, 2 SWS)
Al-Shameri A [L], Al-Shameri A

Biochemie (Übung) (Übung, 2 SWS)
Al-Shameri A [L], Schulz M, Siebert D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1932: Practical Course Biochemistry | Praktikum Biochemie [Pra BC]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 90	**Contact Hours:** 90

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

Description of Examination Method:
The learning results are reviewed by a oral exam (30 min duration) in which the students show that they unterstand the theoretical background of the experiments. Furthermore they should be able to report and discuss the most important results of their practical experiments and answer corresponding questions. In addition, the students prove by correct execution of all laboratory experiments with correct recording (for each experiment about 5 pages of protocol) that they can use the imparted experimental working techniques and can accordingly document laboratory experiments (not graded course achievement).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Practical course microbiology

Content:
In the practical course commonly required basics for working in biochemical labs as well as special methods for separation and characterisation of molecules (amongst others ion exchange chromatography, size exclusion chromatogrpahie, thin-layer chromatography) are imparted. Furthermore, basic biochemical methods are imparted, especially the isolation of nucleic acids and proteins and their analysis by spectroscopy and gel electrophoresis as well as the analysis of enzyme-catalysed reactions.

Intended Learning Outcomes:
After module participation the students are familiar with the execution of experiments in biochemical labs and able to use the mediated experimental methods at least in main features. In addition, they possess a deeper understanding of the theories which underlie the experiments. Furthermore, the students can report laboratory experiments in a correct way and evaluate and

analyse them by means of the theoretical backgrounds under guidance. They can question their results critically and review them for plausibility.

Teaching and Learning Methods:
Laboratory experiments in small groups under guidance with previous introduction of the theory related to the particular experiments as well as analysis of the results by experiment reports. The students practice in excercises how to document and analyse experiments based on given case studies. The acquired skills are then applied by documenting and analysing own results. The students will conduct approx. 12 experiments.

Media:
Practical course script, PowerPoint presentations, blackboard sketch, lab, lab equipment

Reading List:
Practical course script

Responsible for Module:
Dr. Barbara Beer und Dr. Enrico Hupfeld

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

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

Module Description

WZ1933: Molecular Biology and Genetics | Molekularbiologie und Gentechnik

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 8	**Total Hours:** 240	**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:
The performance of the exam consists of a written test (90 min) in which the students show that they are able to call up and structure their theoretical and practical knowledge and use it on problems. During the examination the tasks are set in both languages and the processing of the examination tasks can take place either in German or English. By creating written protocols of the executed laboratory experiments (for each experiment about 5 pages of protocol), the students prove that they can documentate and illustrate theoretical principles as well as the results and the corresponding analysis and assessment of the experiments (not graded course achievement).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module Biochemistry and module Practical course biochemistry

Content:
molecular structure of DNA, plasmids, bacteriophages, mutagenesis strategies, bacterial genomes, prokarotic gene regulation, transformation of organisms, genetic engineering, genetic engineering regulation, genome editing, cloning of DNA fragments, heterologous gene expression, analysis methods for DNA, RNA and proteins

Intended Learning Outcomes:
After completion of thep□estudentsn asses knowledge aboul theyestomfo toulmoleculaeb

including the benefits of new transgenic strains for sustainable production processes. The students can perform and analyse molecular biological experiments and name possible sources of error.

Teaching and Learning Methods:
The theoretical basics of the experiments conducted in the practical course will be delivered in the lecture part via ppt-presentations, movies and white board. In the practical course, the students will self-reliantly perform, document and analyse their experiments.

Media:
PowerPoint, blackboard work, practical course script

Reading List:
Molekulare Genetik: Knippers, ISBN: 987-3-13-477009-4, Bioanalytik: Lottspeich, ISBN: 978-3827400413, script

Responsible for Module:
Blombach, Bastian; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekularbiologie und Gentechnik (Vorlesung) (Vorlesung, 2 SWS)
Blombach B [L], Blombach B

Molekularbiologie und Gentechnik (Praktikum) (Praktikum, 4 SWS)
Blombach B [L], Blombach B, Glawischnig E, Hädrich M, Vital S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1934: Enzymes and Their Reactions | Enzyme und ihre Reaktionen [EnzReact]

Version of module description: Gültig ab summerterm 2024

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	suK

Intended Learning Outcomes:
After sucessful completion of the module the students know and understand enzyme-catalysed chemical reactions and their meaning for an enhanced sustainibility in chemical synthesis. Based on this knowledge the students are able to design single- and multi-stage enzymatic processes and to evaluate them by means of thermodynamic and kinetic reaction data. Students will thus have the fundamental knowledge for more advanced courses, especially on the bioengineering of enzymes as catalysts for new, sustainable industrial chemical processes.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations, blackboard sketches and working on data bases. Corresponding to the teaching content exercise sheets are prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentations, PowerPonit, lecture script, exercise sheets, computer based work and enzyme reaction data bases

Reading List:
Voet, D. , Voet, J.G., Biochemistry 4th Edition, Wiley-VCH, 2011; Perry A. Frey und Adrian D. Hegeman, Enzymatic Reaction Mechanisms, Oxford Univ Press, 2006; Reinhard Renneberg, Darja Süßbier, Biotechnologie für Einsteiger, 3. Auflage, Spektrum Verlag Heidelberg 2010; A. Liese, K. Seelbach, C. Wandrey, Industrial Biotransformations, Wiley-VCH, 2006

Responsible for Module:
Sieber, Volker; 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

WZ1936: Mixture Thermodynamics and Mass Transfer | Thermodynamik der Mischungen und Stofftransport

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 exam performance is effected by a written test. The familiarising of the students with the basics and methods of molecular mass transport and the thermodynamics of mixed phases as well as the reference to real assignment of tasks is reviewed by calculations and by the evaluation of diagrams. The students prove the comprehension of the content of the module by application of the learned relations. Thereby the whole procedural spectra is extended for the chemical and material topics. The students calculate chemical equlibria and phase equilibria. Exam duration: 120 minutes.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basics of Mathematics, Physics and Chemistry, Physical Chemistry

Content:
Introduction to phenomenological thermodynamics, data on chemical media, mass transport phenomena and equilibrium state. Graphical presentation of state variables, thermal state equations for ideal and real pure substances, Gibbs's Thermodynamics, application of the Maxwell's relations (Maxwell's equations), caloric standard data, thermodynamics of mixtures, calculation of chemical and phase equilibria, basics of molar transition and equilibria in one and between several phases (mass transition, diffusion processes, mass transfer), chemical potential, ideal and real phase equilibria, equilibrium coefficients, equilibrium diagrams, mass/ energy/ momentum balance, Fick´s law, film theory, penetration theory.

Intended Learning Outcomes:
The lecture is aimed at familiarising the students with the basics and methods of molecular mass transport and the thermodynamics of mixed phases. Thereby they are qualified to understand the different calculation methods for material properties and phase equilibria in process engineering and to estimate their application possibilities and limits. Thereby the basics for further understanding of thermal and chemical processes are laid.

Teaching and Learning Methods:
The module consists of a lecture during which also exercises will be performed alternately. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Presentations, slide scripts, exercises

Reading List:

Responsible for Module:
Burger, Jakob; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Thermodynamik der Mischungen und Stofftransport (Vorlesung) (Vorlesung, 2 SWS)
Burger J [L], Burger J, Staudt J

Thermodynamik der Mischungen und Stofftransport (Übung) (Übung, 2 SWS)
Rosen N [L], Burger J, Rosen N
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1938: Thermal Process Engineering | Thermische Verfahrenstechnik [TVT]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 exam performance is effected by an oral test. Arithmetic problems concerning fluid separation processes are assigned. Therefore design and mass balance study of process steps and implementation of basic concepts and relations in the field of fluid separation processes are proven. Exam duration: 20 minutes.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Physical Chemistry, Mixture thermodynamics and mass transfer

Content:
Introduction to fluid separation processes, design methods (calculation and graphical), single-stage and multi-stage operations, Mc-Cabe-Thiele-Construction, HTU-NTU-concept, fixed-point construction for extraction columns, feasibility limiations of unit operations. Applications in the field of distillation, absorption, extraction, membranes, adsorption.

Intended Learning Outcomes:
After completion of the module, the studens are able to design and assess the fluid separation processes distillation, extraction, absorption and membranes based on state diagrams. In addition, the students understand the basic principles of the said separation processsses and the apparatus employd in an industrial context.

Teaching and Learning Methods:
The module consists of a lecture during which also exercises will be performed alternately. Contents of the lecture shall be imparted in speech and by presentation. To deepen their

knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Presentations, scripts, exercises

Reading List:

Responsible for Module:
Jakob Burger (burger@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

WZ1939: Practical Course Process Engineering | Praktikum Allgemeine Verfahrenstechnik [PVT]

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**Language:** German	**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 service is provided in the form of written protocols of the laboratory tests carried out (about 5 experiments and about 4 pages of protocol per experiment). In these, students should prove that they are able to understand the theoretical basis of the experiments, to document their experiments, and to evaluate their results. In addition, they should show that they can discuss deviations from the expected results and possible causes. Evaluation of the practical course as passed/failed. The practical course is only considered passed if the above-mentioned protocol meets the criteria of completeness, correctness and comprehensibility/clarity to more than 50% in each case, whereby feedback is given on a first draft.

Repeat Examination:

(Recommended) Prerequisites:
Chemical and thermal process technology, Technical Thermodynamics, Chemical Thermodynamics and Mass Transport

Content:
Basic operations of process engineering, especially from the chemical, thermal and mechanic range e.g. destillation or particle distribution analysis.The content and the number of experiments are chosen from a of multiplicity of basic operations and rely on the available laboratory equipment.

Intended Learning Outcomes:
After graduation of the practical course, the students know basic processes and principles of process engineering (e.g. destillation, extraction, desiccation or particle distribution analysis and

separation from a gas flow). They know how to design and calculate a chemical, physical or mechanic transformation. Furthermore, they know the process steps which are necessary for it.

Teaching and Learning Methods:
The acquisition of basic principles is prepared by handed out literature.
The student learns the theoretical understanding, the basic engineering of the experiment and the correct use of the installed measurement technique through the graduation of the practical course. The acquisition of these properties is proved at the day of the experiment and comfirmed by producing a report. Thereby also the ability is reviewed to evaluate and report data correctly.

Media:
Practical course script, laboratory equipment

Reading List:
Practical course script, standards: DIN EN ISO 106281-1 and DIN EN ISO 10628-2. The literature is provided at the beginning of the module and does not have to be procured by the student.

Responsible for Module:
Burger, Jakob; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum Allgemeine Verfahrenstechnik (Praktikum, 5 SWS)
Burger J [L], Burger J, Rosen N, Staudt J, Winklbauer L, Wolf C
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1940: Bioprocess Engineering | Bioverfahrenstechnik [BPE]

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	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:
To proof whether the students acquired detailed and differentiated knowledge about concepts, calculations and the general design of various bioprocesses, a written examination takes place with a duration of 90 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The lecture provides a fundamental overview of bioprocess engineering including all relevant process parameters, calculations and balances.This includes basic calculations of generation times, maximal specific growth rates as well as balancing of batch, fed-batch and continous fermentation processes. Furthermore, process relevant parameters such as oxygen transfer rates and heat transfer will be conveyed. Additionally, basic operation unit design as well as scale-up aspects will be examined. Examples of sustainable production processes are also given that use renewable raw materials, are climate-friendly and less harmful to the environment than conventional processes.

Intended Learning Outcomes:
The students acquire detailed and differentiated knowledge about concepts of various bioprocesses. Finally they are able to describe, calculate and design classical as well as complex bioprocesses. They will be able to evaluate the applicability of mathematical modelling of bioprocesses and will use this knowledge to analytically simplify highly complex process variants.

Teaching and Learning Methods:
The lecture will be performed as ex-cathedra teaching to provide the students will all necessary fundamentals. Within the tutorial the students learn how to transfer this knowledge and get practically used with the content of the lecture. The tutorial will be used to internalise the theoretical knowledge based on case studies which allows the transformation on real-world as well as highly specific challenges of bioprocesses.

Media:
Slides, interactive quizzes, scripts, exercise sheets

Reading List:

Responsible for Module:
Prof. Dr.-Ing. Michael Zavrel Nico Geisler

Courses (Type of course, Weekly hours per semester), Instructor:
Bioverfahrenstechnik (Übung) (Übung, 2 SWS)
Geisler N, Zavrel M

Bioverfahrenstechnik (Vorlesung) (Vorlesung, 2 SWS)
Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1941: Practical Course Bioprocess Engineering | Praktikum Bioverfahrenstechnik [PCBPE]

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	**Language:** German	**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:
At the beginning of the practical course, there is a colloquium to ensure that the students have read the internship script/topic sufficiently. The data obtained in the practical tests must be evaluated and analyzed scientifically. Test protocols must be submitted. Passing or failing the module is assessed on the basis of the student's performance in the colloquium, the practical laboratory work and the protocol submitted.

Repeat Examination:

(Recommended) Prerequisites:
Module Bioprocess Engineering

Content:
The practical course serves to deepen the content developed in the lecture Biochemical Engineering. In the internship, the theoretically conveyed basics are deepened by means of selected experiments. These practical experiments include the analysis of typical bioprocess parameters such as the determination of the specific growth rate. In addition, process-relevant offline parameters (e.g. the dry biomass) and online parameters (e.g. O2 and CO2 concentration in the exhaust gas) are recorded experimentally. Through the practical course, the students learn how to develop and optimize sustainable bioprocesses that are more climate-friendly than many conventional processes and help to reduce environmental pollution.

Intended Learning Outcomes:
After participating in the practical course, the students are able to work practically with bioreactors and scientifically evaluate fermentation processes. In addition, the students are able to transfer the

calculations and practical experience they have learned to other complex processes and to use the resources of energy, water and raw materials efficiently.

Teaching and Learning Methods:
The practical course is based on carrying out cultivations in shake flasks and bioreactors. Bacteria and/or yeasts are used as the cultivation organism. Particular value is placed on the students' own initiative in order to promote a solution-oriented and independent way of working. The technical process characteristics are calculated and evaluated based on the recorded data.

Media:
slides, scripts, bioreactor

Reading List:

Responsible for Module:
Prof. Dr.-Ing. Michael Zavrel Dennis Beerhalter Nico Geisler

Courses (Type of course, Wetmhours per se
Praktikum Bioverfahrenstechnik épp
avrel r [, wtegmeyer , avrel s

Module Description

WZ1942: Process Design Project | Anlagenprojektierung

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**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:
The exam performance consists of a project planning in the group and preparation of a group presentation of the main results of the project treatment in the group that records the assignment of tasks, the detailed course of action of the students and the calculation as well as the beyond obtained results. The presentation shows whether the students have learned all the steps which belong to the design of a technical process. The completion of the project work constitutes of a short presentation (15 min) of the students.Thereby the presentation is performed to the other participants of the module (not graded course achievement).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Chemical and thermal process technology, Technical Thermodynamics, Chemical Thermodynamics and Mass Transport

Content:
The content consists of a project work in basic engineering and the corresponding design of a exemplary process or of parts of the process, the usage of calculation tools (like Excel, Mathcad), the examination of profitability and of the basics of project management in line with the teamwork.

Intended Learning Outcomes:
After completion of the module the students know how to approach the planning of a technical assignment of tasks. They are able to acquire required informations, to dimension the system in a correct way and examinate its profitability. So the students can design technical processes. Thereby the reference to real design is laid and the students are able to apply basic work steps.

Teaching and Learning Methods:
The groups are tackled with a design task which can be solved by a correct information search and execution of sub-steps. The formulation of solution(s) is carried out in groups consisting of 2 to 4 students. The lecturers support this learning process by continuous interaction. Thereby the knowledge is intensified in supervised teamworks whereby the expertise is clearly strengthened.

Media:

Reading List:

Responsible for Module:
Burger, Jakob; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Anlagenprojektierung (Praktikum und Übung) (Praktikum, 6 SWS)
Gaderer M [L], Herdzik S, Huber B, Meilinger S, Putra L, Schenker M, Veiltl P

Anlagenprojektierung (Praktikum, 6 SWS)
Zavrel M [L], Beerhalter D, Borger J, Dsouza V, Geisler N, Marino Jara J, Oktay I, Stegemeyer U, van der Walt H, Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1943: Research Internship | Forschungspraktikum

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	Language: German/English	Duration: one semester	Frequency: winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

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

Description of Examination Method:
Exam achievement consists of a graded practical course report (10-15 pages) about contents and results of the practical course containing at least an overview of the level of knowledge relating to the project subject as well as representation of used working methods and a representation of the results including interpretation. In a final grade quality of familiarisation with the topic of experimental work, interpretation of results and written elaboration shall be evaluated.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Research-related works at the chairs and working groups of the TUM Campus Straubing. The students shall each get tasks from the research field of the mentoring examiner. They shall work on these tasks under supervision in form of projects. Topics have to be allocated with regard to content and expertise to one of the core themes (cultivation, economy, material use, energetic use). The students shall largely independently plan project works under supervision of the mentors. Project works shall be documented and evaluated in form of an internship report. Optionally a completing presentation of work progress may be done in form of oral presentations. Project works can also be done in cooperation with external institutions, e.g. companies.

Intended Learning Outcomes:
After having participated in the module the students especially understand principles of approach to (research) projects, planning of project works and critical evaluation of project results beside subject-specific knowledge and working methods each imparted in the practical course in scientific working. The students will be able to apply these principles to new project tasks. Besides they are

able to document, to interpret and summarise project works and results in a meaningful way in written form.

Teaching and Learning Methods:
According to the core theme and topic, e.g. experimental equipment (laboratory), databases, libraries, subject-specific software, project and experiment design software

Media:
dependent on focus and topic e.g. experimental equipment (lab), databases, libraries,subject-specific software, project/ experiment planning software

Reading List:
Technical literature

Responsible for Module:
Prof. Volker Sieber

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Bachelor Pflichtmodul (Praktikum, 10 SWS)
Blombach B [L], Blombach B, Glawischnig E, Hädrich M, Vital S

Forschungspraktikum Bachelor Pflicht (Forschungspraktikum, 10 SWS)
Sieber V [L], Abbas Nia A, Al-Shameri A, Arana Pena S, Dsouza Z, Fornoni E, Friedrichs J, Fuchs A, Giustino A, Grundheber J, Hofer N, Hörnschemeyer K, Hupfeld E, Kampl L, Köllen T, Liu Y, Malubhoy Z, Marosevic M, Matena F, Mayer M, Ostertag T, Raga Carbajal E, Rau M, Romeis D, Rühmann B, Scheerer J, Schieder D, Schulz M, Sieber V, Siebert D, Skopp A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1944: Bachelor's Thesis | Bachelor's Thesis

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 12	**Total Hours:** 360	**Self-study Hours:** 40	**Contact Hours:** 320

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

Description of Examination Method:
The module is completed with the preparation and positive evaluation of the Bachelor´s Thesis (depending on selection of topics 10 to 25 pages).

Repeat Examination:

(Recommended) Prerequisites:
120 credits, including all compulsory modules from the first four semesters, according to the module plan of the respective bachelor's program

Content:
consolidation of the knowledge of a specific biotechnological / bioeconomic topic which is arbitrary in consultation with the supervisor / consolidation of practical skills in the lab / presentation of a research-based topic in the field of biotechnology / Bioeconomy

Intended Learning Outcomes:
After completion of the module, the students are able to work self-reliant on simple scientific problems on the basis of scientific methods and analytical thinking. The can present their results in a conclusive way, are able to discuss and to draw conclusions.

Teaching and Learning Methods:
During the Bachelor´s Thesis, the students work on a scientific problem. At this juncture amongst others literature research as well as lab work and presentations are used. The actual teaching and learning methods depend on the respective problem and have to be discussed with the supervisor for each single case.

Media:
Specialist literature, software and so on

Reading List:
in consultation with the supervisor

Responsible for Module:
Prof. Anja Faße Prof. Volker Sieber

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

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

Module Description

WZ1947: Introduction to Electrochemistry | Einführung in die Elektrochemie

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer 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:
Das Erreichen des Lernziels wird durch eine Klausur überprüft (Prüfungszeit: 60min). Auf die Note dieser schriftlichen Prüfung können bis zu 10% der Gesamtpunktzahl als Bonuspunkte angerechnet werden. Dabei legen die Ergebnisse der Onlinetests, die während des Semesters abgehalten werden, die Höhe der Bonuspunkte fest. Es müssen mindestens 65% der Punkte im Onlinetest erreicht werden, um Bonuspunkte zu erhalten. Dabei ist die Anhebung der Note von 4,3 oder schlechter auf 4,0 nicht möglich. Dies soll die Studierenden animieren kontinuierlich an den für sie sehr wichtigen Vorlesungen und Übungen teilzunehmen. Anhand von Fragen zu elektrochemischen Aspekten weisen die Studierenden nach, dass sie die entsprechenden Fachbegriffe, Bezeichnungen und Inhalte kennen, die grundlegenden Zusammenhänge verstanden haben und ihr Wissen über die ablaufenden Reaktionen im Rahmen der kinetischen und thermodynamischen Zusammenhänge anwenden können. Dazu werden konkrete rechnerische Aufgaben gestellt.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Erfolgreiche Teilnahme am Modul „Allgemeine Chemie“, „Physikalische Chemie“, „Mathematik“ und „Physik“ oder vergleichbare Kenntnisse.

Content:
- Konzepte der Elektrochemie: elektrochemische Thermodynamik (elektrochemisches Potential, Elektrodenpotential, Nernst Gleichung), Transport in Lösungen (Migration, Diffusion und Konvektion), Thermodynamik von Grenzflächen (die elektrochemische Doppelschicht), elektrochemische Kinetik.

- Aufbau einer elektrochemischen Messung und das Funktionsprinzip eines Potentiostats (Aufbau, Funktion und Anwendung).
- Stationäre Voltammetrie (Potentialsprung, lineare und zyklische Voltammetrie an Makro- und Mikroelektroden) für die Bestimmung von thermodynamischen und kinetischen Parametern.
- Mechanismen gekoppelter homogener Reaktion zur Energiekonversion und Elektrosynthese.
- Beispiele für die Anwendungen von Elektrochemie in realen Systemen (Gewinnung und Konversion erneuerbarer Energien, grüne Elektrosynthese).

Intended Learning Outcomes:
Die Studierenden erinnern das Basiswissen über fundamentale Konzepte der Elektrochemie und elektroanalytischen Chemie. Sie sind in der Lage, mit den generellen Prinzipien der Elektrochemie umzugehen und diese auf vereinfachte Probleme von realen elektrochemischen Systemen anzuwenden. Ein besonderer Fokus liegt hierbei auf dem Verständnis des allgemeinen und zeitlichen Zusammenspiels von Elektronentransfer, chemischen Reaktionen und Massentransport, welche die elektrochemische Antwort des Systems definieren. Des Weiteren sind die Studierenden vertraut mit industriell relevanten Prozessen und wie die Elektrochemie bei nachhaltiger Energiegewinnung und -speicherung helfen kann. Zusätzlich können sie die erlernte Theorie auf reale Beispiele aus Forschung und Industrie anwenden.

Teaching and Learning Methods:
In dieser Vorlesung werden die Lehrinhalte durch Vorträge des Dozenten anhand von Textdokumenten, PowerPoint-Präsentationen und Tafelbildern vermittelt. Dies ermöglicht eine detaillierte Darstellung des Lehrinhaltes und die Studierenden sind in der Lage Fragen zu stellen und zu diskutieren, sobald diese entstehen. PowerPoint Folien und Tafelbilder helfen als visuelle Unterstützung, um die komplexen Zusammenhänge in der Elektrochemie zu verstehen. Zusätzlich werden den Studierenden Übungsaufgaben zur Festigung des in der Vorlesung gelernten Inhaltes bereitgestellt. Die Lösungen dieser Übungsaufgaben werden später in einer Übungsstunde von den Studierenden präsentiert und diskutiert.

Media:
Präsentationen, Moodlekurs mit Onlinetests, Übungsblätter, Fragenkatalog, PowerPoint, Skript

Reading List:
Elektrochemie, Hamann/Vielstich, ISBN: 3527310681
Electrochemical Methods: Fundamentals and Applications; Bard/Faulkner, ISBN-13: 978-0471043720

Responsible for Module:
Prof. Nicolas Plumeré

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Elektrochemie (Übung) (Übung, 1 SWS)
Plumeré N [L], Höfer T

Einführung in die Elektrochemie (Übung) (Übung, 1 SWS)
Plumeré N [L], Höfer T

Einführung in die Elektrochemie (Vorlesung) (Vorlesung, 2 SWS)
Plumeré N [L], Plumeré N

Einführung in die Elektrochemie (Vorlesung) (Vorlesung, 2 SWS)
Plumeré N [L], Plumeré N
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1948: Methods of Systems biology | Methoden der Systembiologie

Version of module description: Gültig ab winterterm 2018/19

Module Level: Bachelor	**Language:** German	**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:
The teaching content will be evaluated by a written examination for the learning outcomes of the module of a duration of 60 minutes. Based on questions to definitions and methods of systems biology the students prove that they know the corresponding technical terms, designations and contents, that they have understand the basic relations and are able to apply their knowledge.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The lecture provides a fundamental overview of Systems Biology, which includes all relevant analytical methods (omics-technologies). This will include the effect of targeted approaches on the wholitic cell system.

Intended Learning Outcomes:
The students acquire detailed and differentiated knowledge about concepts and definitions of Systems biology. Especially the different omics technologies will be highlighted which mainly defines the approach of systems biology. Finally the students will be able to apply and analyse the different omics technologies and achieved data to describe whole and evaluate cellular processes. Especially the effects of targeted manipulations of the cellular system will be in the focus to be avaluated and described by the students after this module.

Teaching and Learning Methods:
The lecture will be perormed as ex-cathedra teaching to provide the students will all necessary fundamentals which they will need for insights in the different cellular systems. Additional basic introduction into data analysis of the different omics technologies will be applied.

Media:
PowerPoint, short films, scripts

Reading List:

Responsible for Module:
Bastian Blombach (bastian.blombach@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

WZ1949: Protein Chemistry | Protein Chemistry [ProtCh]

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor	**Language:** German/English	**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:
The learning results are proved in form of a written test (60 min exam duration). Based on questions to synthesis, purification, modification, analytics, characterisation and implementation of proteins the students prove that they know the corresponding technical terms, designations and contents, that they have understand the basic relations and are able to apply their knowledge. During the examination the tasks are set in both languages and the processing of the examination tasks can take place either in German or English.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the modules "Biochemistry" and "Practical course Biochemistry".

Content:
Basic principles of protein chemisty, chemical and biochemical protein synthesis, protein folding, amino acid analysis, posttranslational modifications, protein sequencing, prediction of secondary structures, tertiary structures, pI, determination of sulfylhydryl and disulfide groups, desalinisation, protein data bases, methods for protein immobilisation and labeling

Intended Learning Outcomes:
After sucessful completion of the module the students are able to describe and explain basic concepts, phenomenons and relations in the field of protein chemistry. The students can describe biological and chemical methods of protein synthesis, purification and modification of proteins and know how proteins can be characterised. In addition they can describe the impact of modifications on the protein structure or activity and apply their theoretical knowledge by means of questions.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations and blackboard sketches. Corresponding to the teaching content exercise sheets are prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentations, PowerPoint, script, exercise sheets

Reading List:
Bioanalytik, F. Lottspeich, H. Zorbas, Spektrum Akademischer Verlag
Voet, D. , Voet, J.G., Biochemistry 4th Edition, Wiley-VCH, 2011; Nelson, D.L, Cox, M.M., Lehninger Principles of Biochemistry 5th Edition, WH Freeman, 2008; Berg, J.M, Tymoczko, J.L., Stryer, L., Biochemistry 6th Edition, 2006

Responsible for Module:
Prof. Volker Sieber Ammar Al-Shameri

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

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

Module Description

WZ1950: Biopolymers | Biopolymere [Biopol]

Version of module description: Gültig ab summerterm 2020

Module Level: Bachelor	**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 learning results are going to be proved in form of a written test (90 min). The students answer questions about biopolymers and their physicochemical properties. They prove that they have gained knowledge about the discrimination, classification and extraction of biopolymers within the scope of the module and are able to apply this knowledge. No additives are allowed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic principles chemistry, physics and biology

Content:
The module deals with the structure and the function of polymers derived from nature (biopolymers). Covered are proteins, polysacharides, biogenic polyester, polyisoprenes and lignin. It is illustrated how bioploymers can be obtained from natural sources and which chemical reactions they are able to perform. Thereby the importance of the microstructure as well as the importance of the physicochemical properties in biological functions for the application-technical relevance of the biopolymers used as raw and functional material are covered.

Intended Learning Outcomes:
By attending the module the students are able to discriminate biopolymers and to classify them application-oriented. They know how and from which natural sources biopolymers can be obtained. The students acquire basic knowledge in the understanding of biopolymers and their physicochemical properties and can describe these properties and compare them among each other. Thereby they are able to differentiate suitable biopolymers application-oriented.

Teaching and Learning Methods:
Teaching methods: in the lecture the technical contents are communicated by a talk of the lecturer, supported by PowerPoint and skectches on the blackboard. In relation to the teaching content written tasks are disbursed on which the students work in self-study before the tutorials. The solution and discussion of the tasks as well as the visulaization of the teaching content by working with molecular models takes place in the tutorials. Learning methods: at the postprocessing of the lecture exspcecially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a comprehensive knowlegde about biopolymers.

Media:
Lecture, blackboard sketch, foil script, molecular models

Reading List:
Türk, Oliver: Stoffliche Nutzung nachwachsender Rohstoffe
Grundlagen - Werkstoffe - Anwendungen, Springer Verlag

Responsible for Module:
Zollfrank, Cordt; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Biopolymere (Seminar) (Seminar, 1 SWS)
Zollfrank C [L], Zollfrank C

Biopolymere (Vorlesung) (Vorlesung, 2 SWS)
Zollfrank C [L], Zollfrank C
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1953: Downstream Processing | Downstream Processing [DSP]

Downstream Processing

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The teaching content will be evaluated by a written examination for the learning outcomes of the module of a duration of 60 minutes. Based on questions to definitions and methods of downstream processes of biologically inspired processes the students prove that they know the corresponding technical terms, designations and contents, that they have understand the basic relations and are able to apply their knowledge. Using calculations, the students also show that they can calculate and design downstream processing methods.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module Bioprocess Engineering

Content:
The lecture gives a basic introduction to the downstream processing technologies of bioprocesses, in which all relevant separation methods are discussed. The content ranges from the determination of relevant process variables to the design and scaling up of the technologies. One focus is on avoiding, minimizing and recycling waste streams in order to develop sustainable bioprocesses that conserve resources and do not pollute the environment.

Intended Learning Outcomes:
After participating in the module events, the students are able to define the terminology of the processing technologies of bioprocesses. These include above all the different separation methods, which contribute significantly to the feasibility of fermentation processes and other biologically based manufacturing processes. At the end of the module, the students are able to

develop, design and implement economical and sustainable bioprocesses based on the application and implementation of these processing methods.

Teaching and Learning Methods:
The lecture takes place mainly as frontal teaching in order to familiarize the students with all the necessary basics, which they need for the assessment of targeted and sustainable downstream processes in the field of biotechnology. Individual tasks are elaborated together in the lecture.

Media:
slides, interactive quizzes, short films, scripts

Reading List:

Responsible for Module:
Professor Dr.-Ing. Michael Zavrel

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

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

Module Description

WZ1954: Fluid Mechanics | Strömungsmechanik

Version of module description: Gültig ab summerterm 2021

Module Level: Bachelor	**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 module will be assessed by a written examination. Students calculate tasks of fluidmechanics based on its fundamental equations. In addition, the unterstanding of content is tested by the explanation of theoretical operations. Dimensionless numbers to evaluate complex task are applied and explained. Altogether the students show that they can solve known tasks from the fluid mechanics area and transfer their acquired knowledge to new assignments of tasks.
Exam duration: 90 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of the most important physical correlations (basic parameters with units, definition of pressure, temperature etc.) must be available. Besides formation and solution of systems of equations as well as command of simple integral and differential calculus as well as Physics and Mathematics is a requirement.

Content:
This module provides basics of fluid mechanics, that are relevant for further engineering applications . Therefore the theoretical fundamentals are derived and deepened throug illustrating examples . The content will cover the following topics: hydrostatics, fluid dynamics (Bernoulli , Navier-Stokes , flow resistance), CFD.

Intended Learning Outcomes:
After participating in the module, students are able to understand and analyze simple tasks regarding flows, to apply the methods for their solution and to give a mathematical solution. In particular the students can transfer the learned methodology and the obtained results to new assignments of tasks.

Teaching and Learning Methods:
The module consists of a lecture during which also exercises will be performed alternately. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

Media:
Presentations, slide scripts, exercises

Reading List:
Siekmann, Thamsen: Strömungslehre, 2. Auflage, Springer
Örtel: Strömungsmechanik für Ingenieure und Naturwissenschaftler, 7. Auflage, Springer
[226] Baehr, Hans Dieter; Kabelac, Stephan: Thermodynamik, 14. Auflage, Springer, ISBN 978-3-642-00555-8, 2009
[242] VDI Wärmeatlas, VDI-Gesellschaft Verfahrenstechnik und Chemie-Ingenieurwesen 9.Auflage, Springer-Verlag ISBN 3-540-41201-8 9.Auflage

Responsible for Module:
Gaderer, Matthias; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Strömungsmechanik (Übung) (Übung, 2 SWS)
Gaderer M [L], Huber B

Strömungsmechanik (Vorlesung) (Vorlesung, 2 SWS)
Gaderer M [L], Huber B
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1955: Heat transfer | Wärmeübertragung

Version of module description: Gültig ab summerterm 2021

Module Level: Bachelor	**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:
Exam achievement shall be done in the form of a written test. The students calculate heat transfer tasks. They are able to explain dimensionless quantities and apply them in arithmetic examples. They explain and calculate different mechanisms of heat transfer. Altogether the students show that they are able to understand and solve assignments of tasks from the heat transfer area.
Exam duration: 90 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of the most important physical correlations (basic parameters with units, definition of pressure, temperature etc.) must be available. Besides formation and solution of systems of equations as well as command of simple integral and differential calculus is a requirement.
Physics, Mathematics and Thermodynamics

Content:
In this module knowledge in heat transfer gained from the lecture of Technical Thermodynamics (TTD) shall be extended, deepened computation bases are created and dimensionless numbers are deduced. Topics will be: heat conduction, covection, heat radiation, heat transfer through objects, calculations based on Nusselt and Prandtl number, dimensioning and calculation of heat exchangers, transient heat conduction, influence of phase changes and knowledge transfer on parallel issues in mass transfer.

Intended Learning Outcomes:
After having participated in the module the students are capable of understanding and analysing simple tasks relating to heat transfer (convection, conduction, radiation). Additionaly the student will be able to apply methods to solve problems concerning heat transfer systems.

Teaching and Learning Methods:
The module consists of a lecture during which also exercises will be performed alternately. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the module learned theory shall directly be applied with a practical orientation by means of arithmetic examples. Thus for instance the construction of a heat exchanger is outlined.

Media:
Presentations, slide scripts, exercises

Reading List:
[224] Stephan, P.; Schaber, K.; Stephan, K.; Mayinger, F.: Thermodynamik, Band 1: Einstoffsysteme, 17. Auflage, Springer, ISBN 978-3-540-70813, 2006
[226] Baehr, Hans Dieter; Kabelac, Stephan: Thermodynamik, 14. Auflage, Springer, ISBN 978-3-642-00555-8, 2009
[] Wärme- und Stoffübertragung, Hans Dieter Baehr und Karl Stephan, Springer, ISBN 978-3-642-36558-4 , 2013
[227] HSC Chemistry, Outokumpu Research Oy, Pori, Finnland, A. Roine, Ver. 1.10, 1990
[233] Stephan, P.; Schaber, K.; Stephan, K.; Mayinger, F.: Thermodynamik Grundlagen und technische Anwendungen, Band 2: Mehrstoffsysteme und chemische Reaktionen, 15. Auflage, Springer, ISBN 978-3-540-36709-3, 2010
[234] Gmehlin, J.; Kolbe, B.: Thermodynamik, 2. Auflge, VCH, ISBN 3-527-28547-4, 1992
[235] Atkins, Peter W.: Physikalische Chemie, VCH, ISBN 3-527-25913-9, 1990
[268] GTT-Technologies; Programm Factsage 6.3, http://www.gtt-technologies.de
[242] VDI Wärmeatlas, VDI-Gesellschaft Verfahrenstechnik und Chemie-Ingenieurwesen 9.Auflage, Springer-Verlag ISBN 3-540-41201-8 9.Auflage

Responsible for Module:
Matthias Gaderer (gaderer@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

WZ1959: Master's Thesis Seminar | Masterseminar

Version of module description: Gültig ab summerterm 2017

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 2	**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:
Englisch - Intensive Thesis Writers' Workshop C2 (Workshop, 2 SWS)
Jacobs R, Ritter J, Wellershausen N

Masterseminar (Biomass Technology) (Seminar, 2 SWS)
Zavrel M [L], Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1977: Empirical Methods for Bioeconomy | Empirical Methods for Bioeconomy

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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 achievement of the desired learning objectives as well as the contents of the lecture will be carried out in a written final examination as well as through a oral presentation. In the written exam no tools allowed, Written examination: 60 minutes; The percentage of the written grade is 60%. The oral presentation includes the scientific and results-oriented analysis of a case study elaborated during the exercise. The students show the results individually or in a group in an oral presentation, followed by a discussion with the fellow students and the lecturer. Allowed Tools: Powerpoint; The proportion of the presentation score at the module score is 40%.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Statistics

Content:
This course aims to enable students to design, implement, and evaluate empirical research inthe bioeconomy. In a self-developed case study, the students actively learn the necessary steps to carry out their own empirical research project. The first part of the course includes the necessary steps to collect empirical data (research design, operationalization and measurement, questionnaire design, methods of data collection). The second part focuses on data preparation and cleanup as well as data analysis using descriptive statistics and basic econometric techniques. The students use data visualizations, hypothesis tests, t-test, ANOVA, basic and advanced regression analysis (OLS, logit, propensity score matching, factor analysis, cluster analysis).

Intended Learning Outcomes:
After the course, students are able to understand the nature of the scientific process including deriving hypotheses, questionnaire design, data collection, applied econometrics and results evaluation and discussion, in particular in the context of environmental economic studies. The students can develope structured questionnaires, use and apply selected empirical research methods based on research questions (e.g. Bachelor theses). The students have an overview of the advantages and disadvantages of selected relevant methods. They are able to analyse data by means of surveys using statistical programms such as R.

Teaching and Learning Methods:
The course consists of a lecture and an exercise. The lecture takes place via PowerPoint as well as statistical programs on the PC to present statistical methods and their fields of application. In the exercise, the students design and collect their own data sets based on case studies and apply basic statistical methods for empirical analysis individually and / or in groups. The evaluation is carried out on self-developed examples on the PC by means of the program R.

Media:
Presentations, slide scripts, Articles, PC statistical Program (e.g. R)

Reading List:

Responsible for Module:
Prof. Sebastian Goerg

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

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

Module Description

WZ1978: Green Chemistry | Green Chemistry

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** summer 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 achievement of the learning outcomes will be tested in a written exam and in a seminar. The students are expected to be able to reproduce the course contents correctly and transfer them to different contexts in written form.
The written exam has a duration of 90 minutes. Aids are not permitted. In addition, the contents of the course will be enhanced in a seminar. The proportion of the written exam to the module grade is 80 %. In the seminar, students analyze selected case studies from current literature in the context of Green Chemistry with respect to their sustainability and present these to their co-students and instructor in an oral presentation with short discussion and a brief written composition. The proportion of the seminar grade to the module grade is 20 %.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics of chemistry, physics and biology

Content:
The module contains an introduction to the basics of environment-friendly 'green' synthesis routes for chemical products. The 12 basic principles of 'green engineering' will be covered. Sustainably production and treatment, process optimizations and innovative technological approaches and optimized separation methods will be discussed. The different processes will be presented with respect to relevant environment aspects, sustainability and energy- as well as raw materials consumption.

Intended Learning Outcomes:
After completion of the module, the students are able to describe the basic principles of environment-friendly and sustainable production of chemicals and demonstrate them at the

examples of selected process chains. They can determine and present specific resource requirements with respect to energy, raw- and auxiliary materials as well as the yields during production, emissions into air, water and soil, as well as amounts of wastewater and solid waste. They are alse able to couple syntheses to preceding and subsequent processing steps. Thus, they can assess the sustainabilities of production processes autonomously.

Teaching and Learning Methods:
Lecture with blackboard and slide presentations for the development of technical concepts. Seminar with written tests. Self-study is essential to consolidate the course contents.

Media:
Lecture, blackboard, slides, group work

Reading List:
Jiménez-González, Constable, Green Chemistry and Engineering, Wiley-VCH, 2010

Responsible for Module:
Prof. Herbert Riepl

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

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

Module Description

WZ1980: Production of Biogenic Resources | Produktion biogener Ressourcen

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**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:
Exam achievement shall be done in the form of a test. In this test it shall be proved that students are capable of describing important requirement for the required biogenic resources and are capable to devlop important rules for the production of the raw materials in a limited time. On the basis of different examples (e.g. algae productions) and scenarios the students shall discuss pros and cons and the possibilities for the transformation of the different biomass to products.
Type of exam: In writing
Exam duration: 90 min.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
None

Content:
The module aims at providing in-depth knowledge to the students in the prodution and cultivation of renewable raw materials. Beside the areal-bound production by agriculture and forest, production processes such as Algae bioreactors where integrated. Differences, advantages and disadvantages and possible perspectives are discussed.
Essential crop characteristics shall be discussed for the treated crops and if required differences shall be addressed by various product use (energy and/or industrial crops). As to crops important performance parameters (yields etc.) shall be debated and integration into a concrete cultivation system (farm) be discussed. For this purpose pros and cons shall be worked out and possible actions shall be discussed for optimizing cultivation. For selected topics current main points of research shall be presented and results discussed.

Intended Learning Outcomes:
After having participated in the module units the students know the most important biogenic ressources for renewable raw materials.
- They are capable of describing important requirement for the required biogenic resources and are capable to devlop important rules for the production of the raw materials
- For the desired raw materials, the required starting materials or biomass can be described (e.g. in the form of agricultural crops (example starch production: cereals, maize)). Based on the agricultural and wood procution of raw materials students can characterize the cropping system and cultivation methods
- They are able to describe possible effects on the environment for selected main crops (cereals, corn, oil crops)
- The students know selected research activities in the field of renewable raw materials and are able to analyse their results concerning their relevance and significance

Teaching and Learning Methods:
The module shall primarily be held as a lecture. For different courses it will be completed by individual and group projects. Demonstration of research activities and presentation of the cultivation by practitioners is partly performed by external guests (lecture, presentation). Further reading and questions for follow-up will be made available for different teaching units in moodle.

Media:
Lecture, presentations, (individual and group projects)

Reading List:
Lütke- 2006: Lehrbuch des Pflanzenbaus, Band 2: Kulturpflanzen, Verlag Th. Mann Gelsenkirchen.
Diepenbrock, Ellmauer, Leon, 2009 : Ackerbau, Pflanzenbau und Pflanzenzüchtung. Ulmer Verlag.
Pflanzenbau, Ein Lehrbuch - Biologische Grundlagen und Technik der Pflanzenproduktion, Gerhard Geisler, Paul Parey Verlag: Parasitäre Krankheiten und Schädlinge an landwirtschaftlichen Kulturpflanzen, Ulmer Verlag, G.-M. Hoffmann und H. Schmutterer
Diepenbrock 2014: Nachwachsende Rohstoffe, Ulmer UTB, Stuttgart
Kaltschmitt etal. 2009: Energie aus Biomasse, Springer, Heidelberg

Responsible for Module:
Siebrecht, Norman; Dr. agr.

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

Module Description

WZ1985: Governance of the Bioeconomy | Governance of the Bioeconomy

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**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 will be given in the form of a written examination. The students should be able to name the different actors, measures and potential target conflicts and trade offs based on examples from the lecture and discuss them by means of examples. Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The bioeconomy requires a structural change in a society's operational and economic thinking. This also requires a suitable overall economic regulatory structure (governance) as a framework for action by all economic actors (consumers, politicians, companies, civil society). The design of such framework conditions requires a mix of different instruments (e.g. bans, taxes, standards, subsidies, information) in order to create incentives for structural change. The political framework includes, among other things, climate policy, environmental policy, economic and agricultural policy measures. The course provides an overview of the various actors in the bioeconomy and measures for shaping structural change as well as their economic, ecological and socio-economic effects and trade offs.

Intended Learning Outcomes:
After the event, the students are able to understand the overall economic regulatory structure and identify the respective responsible actors. The students have an overview of the current and potential political measures to promote structural change. Advantages and disadvantages or

possible conflicts of objectives of the control structures in terms of economic, ecological and socio-economic effects can be assessed.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. The lecture takes place using PowerPoint, in which relevant theories and concepts are presented using current examples of governance. Articles and scientific publications from the scientific literature are integrated into the lectures. In the exercise, students develop political governance systems based on examples developed together, present them and discuss the empirical examples individually and/or in groups from different perspectives of the economy.

Media:
Presentations, slide scripts, articles

Reading List:
Paul Krugman and Robin Wells, Microeconomics, 6th Edition, Worth Publishers, 2020, (ISBN 13: 978-1-319-24528-3)
https://seea.un.org/

Responsible for Module:
Faße, Anja; 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

WZ1986: Evidence Based Management and Policy | Evidence Based Management and Policy

Version of module description: Gültig ab winterterm 2018/19

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 180	**Contact Hours:** 120

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

Description of Examination Method:

The examination performance is provided in the form of a written and oral examination. In the written exam, the students should prove that they know basic game theories and can discuss with examples. no aids allowed, duration of examination: 60 minutes, oral examination: presentation with Powerpoint, presentation of own results and the underlying self-developed strategy during the simulation game, discussion with instructors about determinants of success or a necessary

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importance of communication between different interest groups and decision-makers, the ability to negotiate and the ability to deal with conflicts.

Teaching and Learning Methods:
The module consists of a lecture and a tutorial. The lecture is designed as an interactive frontal lesson (PowerPoint, blackboard), because in this module a large number of theories from game theory are dealt with.
In Übing, the lecturer, as the game master, conducts a strategic simulation game with the students, which lasts several weeks, including the evaluation.
During the simulation, students design their own strategies according to their role. The participants assume the roles of various actors involved and play the negotiation and decision-making processes prescribed by the scenario. Topics eg: The participants in the role of government ministers (such as research and development, environment, agriculture, development cooperation, labor) lead the fortunes of their country. They deepen their knowledge in economics, sustainable development and environment / ecology. Careful handling of existing information, the consideration of interactions, late and secondary consequences of decisions and good teamwork are important for a successful work in the business game.

Media:
Presentations, slide scripts, computer

Reading List:

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar Evidence Based Management and Policy (Seminar, 4 SWS)
Goerg S, Pondorfer A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1989: Markets of biogenic resources | Märkte Nachwachsender Rohstoffe

Version of module description: Gültig ab winterterm 2018/19

Module Level: Bachelor	**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 a written test it shall be demonstrated that questions relating to theoretical aspects of function of markets as well as the development of selected markets to energetic and material use of biogenic resources can be solved in a limited time without tools. Type of exam: In writing; Exam duration: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Expertise related to marketing is an advantage

Content:
The module provides a good entry into the markets of biogenic resources. At the beginning of the course the basic functions and functioning of markets are explained to the student. Later this basic knowledge is used to illustrate the development of selected markets of biogenic resources. Thereby important markets for energy use of biomass (such as bioenergy, biofuels, renewable power production) are considerd as well as relevant markets for material use (such as bulk chemicals, biogenic insulation materials, biomaterials, WPC, bioplastics, biocosmetics, tensides) taking into account the entire value chain from biomass production until the private consumer.

Intended Learning Outcomes:
After having participated in the module units the students are capable of explaining the principle functions and mechanisms of markets. Furthermore they know the volume and relevance of important markets using biogenic resources. Additionally they are able to analyse these marketsas well as to define and to explain important influencing factors for market development.

Teaching and Learning Methods:
By means of a lecture the basic principles of markets as well as the development of markets of biogenic resources shall be presented. By means of a lecture theoretical knowledge can best be imparted.

Media:
Slide scripts and presentations

Reading List:
Actual literature will be announced during the lecture.

Responsible for Module:
Menrad, Klaus; Prof. Dr.sc.agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung
Märkte Nachwachsender Rohstoffe
4SWS
Klaus Menrad
Thomas Decker
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2937: Advanced Development Economics | Advanced Development Economics

Version of module description: Gültig ab summerterm 2017

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 will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. Type of examination: written, no additional tools allowed, duration of examination: 90 minutes

Repeat Examination:

(Recommended) Prerequisites:
Mikroökonomie, Makroökonomie

Content:
Why are some countries developing and some are trapped in poverty? What are the determinants of economic growth? What is the role of demography, institutions (in particular the state), the environment, labor, migration, capital or credit markets in the development of states? What is the importance of development aid & assistance? These are some of the questions that decision-makers in the developed and developing countries have to discuss every day. This course provides a theoretical foundation and empirical evidence for the analysis of the most important questions of today's development of the world.

Intended Learning Outcomes:
After visiting the module, the students can use the development economy to understand what is hindering development and what factors lead to success. They can apply theories, concepts, and analytical techniques associated with macroeconomics. Students learn to understand the difference between growth and development, the reasons and impact of migration, the role of institutions (especially the state), development aid and international trade. The students are able to

analyze empirical evidence on economic development and to critically read the literature in the field of economic development.

Teaching and Learning Methods:
The lecture and the tutorial take place by means of powerpoint. In Addition articles from newspapers and scientific journals will be integrated into the lectures. Based on the provided references, students will discuss concepts and derived hypotheses individually and/or groupwise from different perspectives. Online lectures from international renowned experts and researchers will be integrated in the lecture.

Media:
Presentations, slide scripts, Articles, online lecture examples

Reading List:
Alain de Janvry, Elisabeth Sadoulet (2016). Development Economics - Theory and Practice. Routledge; Michael Todaro, Stephen Smith (2012). Economic Development, Pearson.

Responsible for Module:
Anja Faße a.fasse@wz-straubing.de

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Development Economics (Lecture) (Vorlesung, 2 SWS)
Faße A [L], Faße A

Advanced Development Economics (Tutorial) (Übung, 2 SWS)
Faße A [L], Faße A, Shayo G
For further information in this module, please click campus.tum.de or here.

Module Description

WZ8105: Practical Course Enzyme Optimization | Praktikum Enzymoptimierung

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4	**Total Hours:** 121	**Self-study Hours:** 61	**Contact Hours:** 60

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

Description of Examination Method:
The intended learning outcomes are verified by a two-piece “Laborleistung” in the form of a written report and a oral presentation. The written laboratory report serves to deepen the scientific documentation and evaluation competences in the field of enzyme engineering. The presentation serves to test the presentation competence of scientific topics in front of an audience.
The written report contains a description of the three experiments and measurements carried out during the practical course, divided into introduction, execution/evaluation and insights gained (discussion).
Important additions are the respective theoretical basics incl. literature study and the necessary calculations.

The report represents 90 % and the presentation 10 % of the overall grade of the practical course.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites for successful participation are knowledge in molecular biology, microbiology, protein chemistry and enzyme engineering.
Proof of the necessary previous training is a prerequisite for successful completion of the internship. Students who have taken the module "Enzyme Engineering" are exempt from this requirement. We reserve the right to check the prerequisites.

Content:
This course is intended to impart the molecular biological and protein chemical methods for the optimization of enzymes by means of two relevant examples. Essential contents are:

1. rational/computer-based approach: local (random) mutagenesis based on sequence comparisons, structural analyses and computer models,
2. purely evolutionary approach: local mutagenesis and recombination. In both approaches, assay methods are established, robots are used for high-throughput analysis and encapsulation methods for enzyme screening are applied.
3. application of optimized enzymes for simple technical conversions (enzyme immobilization, product quantification, enzyme recycling).

Intended Learning Outcomes:
After participating in the course, the students will be able to perform various methods for enzyme optimization and to practically execute the essential elements (variant production, assay construction and screening, operation of necessary hardware) as well as to design simple enzymatic processes.
In addition, they can scientifically evaluate and document their results in the field of enzyme engineering.

Teaching and Learning Methods:
The practical training takes place as a block event in Straubing (4 SWS). The experiments are carried out independently in small groups (maximum 3 persons). The contents of the module are discussed and queried at the beginning of each practical training day. The practical course following the lecture offers concrete possibilities for learning and applying standard methods used in enzyme optimization.

Media:
A script of the practical course will be made available to the students in time. At the beginning of each day during the practical course, the upcoming work steps will be discussed using PowerPoint slides and blackboard notes, and questions will be answered.

Reading List:
Recommendations:
"Directed Enzyme Evolution: Screening and Selection Methods” (Methods in Molecular Biology) and “Directed Evolution Library Creation: Methods and Protocols” (Methods in Molecular Biology), both Frances H. Arnold, George Georgiou (publisher), Springer, Berlin
“Protein Engineering Protocols” (Methods in Molecular Biology), Katja M. Arndt and Kristian M. Muller (publisher), Springer, Berlin

Responsible for Module:
Volker Sieber (sieber@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

WZ8107: Enzyme Engineering | Enzym Engineering

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 100	**Contact Hours:** 80

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

Description of Examination Method:
The intended learning outcomes of the lecture are examined with a written test within 90 minutes. Contents are molecular biological and protein chemical questions about enzyme optimization. These questions ask the students for their knowledge and understanding of the issues of the lecture as well as their opinions about some of the dilemmas raised within the lecture. The students are allowed to use a calculator. With this test it will be ensured that the acquired knowledge can be applied as well as transferred to similar issues and questions.
The intended learning outcomes of the practical course are examined with a written report. With this report, the students have to show that they understood the used methods and how to evaluate the results. Furthermore they have to discuss those results in alignment with the expectations they made in advance. The report is complemented with a 30 minutes presentation, in which the understanding of the learning outcomes of the practical course is examined during the running practical course.
The exam accounts for 60 %, the report for 40 % of the overall assessment.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites for a successful participation are skills in technical biocatalysis and basic knowledge in molecular bacterial genetics, protein chemistry and bioinformatics.

Content:
Contents of the lecture and the associated seminar are molecular biological as well as protein chemical approaches for the optimization of enzymes. Traditionally, those approaches convey a variation of the primary structure of the protein of interest.
Essential contents are:

Analysis of enzymatic limitations on the molecular level as well as rational methods and computer-aided methods for site determination; Evolutionary, randomized mutagenesis processes and recombination techniques as well as high throughput screening processes and robotics.
The practical course conveys molecular biological as well as protein chemical methods used for the optimization of enzymes, by means of two technically relevant examples.
Essential contents are:
1. Rational and computer-aided approach – A site-directed (random) mutagenesis, whose targets are selected by means of sequence alignments, structural analysis and computer models.
2. Evolutionary approach – A completely randomized mutagenesis is used to create randomized protein variants, which, then, are screened and evaluated.
Both examples make use of state-of-the-art assay methods. Furthermore, the optimized enzymes will be used for simple technical implementations (i.e. enzyme immobilization, product quantification and enzyme recycling) to show the value of enzyme optimization processes

Intended Learning Outcomes:
After participating in the lecture, the students are able to develop enzyme engineerings processes to enhance technically limitated enzymes. They are able assess the necessary effort for those enzyme engineering processes. Furthermore they possess the theoretical background to successfully implement the used methods in the subsequent Enzyme Engineering practical course.
After participating in the practical course, the students are able to perform standard methods that are used for enzyme optimization processes. The essential steps are: mutant generation, assay development, evaluation of results and handling and controlling of essential devices)

Teaching and Learning Methods:
A lecture conveys the topic „molecular biological and protein cheimcal approaches for enzyme optimization processes“. A seminar, where the students present current and relevant publications, internalizes and deepens the teaching contents. A practical course, which takes place subsequent to the lecture, offers specific ways to learn and apply methods used in enzyme optimization processes.

Media:
Black board and PPT-presentations are used. The PPT-slides will be available for the students in advance or shortly after the lecture session was held.

Reading List:
Recommendations:
"Directed Enzyme Evolution: Screening and Selection Methods” (Methods in Molecular Biology) and “Directed Evolution Library Creation: Methods and Protocols” (Methods in Molecular Biology), both Frances H. Arnold, George Georgiou (publisher), Springer, Berlin
“Protein Engineering Protocols” (Methods in Molecular Biology), Katja M. Arndt and Kristian M. Muller (publisher), Springer, Berlin.

Responsible for Module:
Sieber, Volker; 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

WZ9385BOK: Survey Research in the Social Sciences | Wirtschafts- und sozialwissenschaftliche Umfrageforschung

Version of module description: Gültig ab summerterm 2011

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

WZ9422BOK: Technology Manure Utilisation | Technik der Biomasse und Wirtschaftsdüngernutzung

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
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:
Assessment criteria:
active participation in the course (active participation in discussions, exercises, excursion)
Assessment: written examination

Repeat Examination:

(Recommended) Prerequisites:

Content:
1 Ecological fundamentals 1.1 Environmentally relevant elements and compounds 1.2 Circulation of substances 1.3 Nutrient and pollutant balances 2 Legal regulations, environmental protection measures 3 Biogenic emissions from agriculture (odours, NH_3, CH_4, N_2O) 3.1 Mechanism of formation, sources, mitigation strategies 3.2 Guidelines on assessment of ambient air from animal husbandry 4 Agricultural manures 4.1 Farmyard manure 4.1.1 Methods of farmyard manure removal 4.1.2 Methods of farmyard manure storage 4.1.3 Methods of farmyard manure treatment 4.1.4 Methods of farmyard manure spreading 4.2 Liquid manure 4.2.1 Liquid manure properties 4.2.2 Methods of liquid manure removal 4.2.3 Methods of liquid manure storage 4.2.4 Methods of liquid manure treatment 4.2.4.1 Mixing and pumping 4.2.4.2 Aeration 4.2.4.3 Separation 4.2.4.4 Liquid manure additives 4.2.5 Methods of liquid manure spreading 4.2.5.1 Tankers and spreading equipment 5. Energy production from biomass 5.1 Biogas production 5.1.1 Potential (manures, organic wastes, energy plants) 5.1.2 Anaerobical, biochemical degradation 5.1.3 Types of biogas plants 5.1.4 Energy efficiency of biogas plants 5.1.5 Energy conversion, electricity and heat from biomass (FC, HPC, MGT) 5.2 Solid fuels 5.2.1 Harvesting and conditioning 5.2.2 Firing systems 5.3 Fuels 5.3.1 Vegetable oils 5.3.2 Ethyl alcohol

Intended Learning Outcomes:
To know areas of problems and conflicts in protection of environment and climate in agriculture, to point out causes of and solutions to problems and conflicts. To know and evaluate the broad range of methods of manure storage, treatment and spreading. To develop methods of manure management with low nutrient losses, high nutrient efficiency and low environmental impact. To apply guidelines on assessment of emissions from animal husbandry. To describe methods of energy production from energy plants and biomass (biogas production, solid fuels, fuels).

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

WZ9427BOK: BOKU: Chemicals from Biomass | BOKU: Chemikalien aus Biomasse

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
oral

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
General and organic chemistry

Content:
Master HTM - Modul Bioraffinerie

The lecture gives a short introduction into the different classes of primary and secondary natural materials.

Based on the corresponding properties of these natural materials substantial applications and utilisations within the framework "Chemicals from Biomass" are elaborated and described.

Intended Learning Outcomes:
Master HTM - Modul Bioraffinerie
Establish understanding of interrelationship of the different classes of primary and secondary natural materials, their properties and resulting possible usage. Deepening knowledge about connectivity of chemical properties and usage as biobased chemicals.

Teaching and Learning Methods:
Class lecture

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Chemikalien aus Biomasse (LV-Nr. 774326)
2 SWS
Sabine Baumgartner, Stefan Böhmdorfer

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

Module Description

WZ9428BOK: Technology of Wood Processing | Technologien der Holzverarbeitung

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
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:
written
oral examination

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Characterization of the raw material Wood (grading etc.) and principles of converting the raw material wood into a material and wood-base products. Principles of slicing, sawing, milling, chipping etc. drying and glueing.

Intended Learning Outcomes:
Understanding of the relationship of wood as a raw material and the wood-based materials and products along the process chain wood and the approbiate technologies. Knowlegde of the most common wood based materials, their properties and potential applications incl. relevant Standards.

Teaching and Learning Methods:
Vorlesung interaktiv mit Studierenden

Media:

Reading List:

Wagenführ, A., Scholz, F., Taschenbuch der Holztechnik. Fachbuchverlag Leipzig, Leipzig 2005
Fellner, J., Teischinger, A., Zschokke, W.: Holzsprektrum. proHolz Austria, Wien 2007

Responsible for Module:

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

Vorlesung (1 ECTS)
Technologien der Holzverarbeitung (LV-Nr. 891330)
1 SWS
Alfred Teischinger

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

Module Description

WZ9431BOK: Biobased and Biodegradable Plastics | Biobasierte und biologisch abbaubare Kunststoffe

Versio

~Processing and forming
Chemical derivatisation/synthesis; moulding (especially thermoplastic moulding); examples for applied moulding processes

~Characterisation of material properties:
Structures and microstructure; mechanical properties and corresponding analytics and measuring techniques (thermal resistance; deformation resistance, ...)

~Biodegradability and disposal
Material properties with respect to degradability; degradation, certification and labelling; analytics; ecology; legal background (approval, registration, technologies for disposal

Intended Learning Outcomes:
The students are able to distiguish between the terms "biobased", "biodegradable" and "compostable" and they are able to relate materals to the appropriate terms.
They are able to name the most important biobased and biodegradable plastics and can describe their production processes and properties. In addition they are able to critically assess current developments and discussions on biobased materials. They know the most important processing technologies and methods for the characterisation of material properties. The students are familiar with chemical, biological, technical, ecological and legal aspects of biodegradation and are able to apply this knowledge in practice.

Teaching and Learning Methods:
Mixed lecture and discussion

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Biobasierte und biologisch abbaubare Kunststoffe (LV-Nr. 970304)
2 SWS
Markus Neureiter, Ines Fritz, Norbert Mundigler, Rupert Wimmer

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

Module Description

WZ9435BOK: Resource and Environmental Economics | Resource and Environmental Economics

Version of module description: Gültig ab winterterm 2017/18

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

WZ9451BOK: Post-harvest Technology for Renewable Energy Plants | Nacherntetechnologie - Grundlagen für Nawaros

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
written
The grades for the course will be calculated according to the number of points achieved and based on the following grading scale:
90 – 100 Points = very good (1)
78 – 89 Points = good (2)
66 – 77 Points = satisfactory (3)
55 – 65 Points = adequate (4)
0 – 54 Points = inadequate (5)

The written examination will last 60minutes.
Calculator, ruler and the supplied formulary from bokulearn are allowed to use.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
principles of thermodynamics

Content:
The course focuses on special topics of post harvest technologies in the field of renewable raw materials. An overview of preservation methods will be given. The fundamentals of drying and the relation to material properties are explained. Measurement equipment and their usage for the main measurement parameters in the field of postharvesting will be presented and demonstrated. The most important types of dryers will be explained. Technologies for sorting and classification for renewable and raw materials will be explained. Examples in the field of renewable raw material will

Module Description

WZ9452BOK: Spanish III (A2) | Spanisch III (A2)

Version of module description: Gültig ab winterterm 2017/18

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 2	**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

WZ9453BOK: English | Englisch

Version of module description: Gültig ab winterterm 2017/18

Module Level:	Language:	Duration:	Frequency:
Credits:* 2	**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

WZ9454BOK: Energy Economics and Politics | Energiewirtschaftspolitik

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
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:
The assessment consists of three parts. Students have to pass a test, write a seminar paper and review and present the paper of a fellow student. To allow for a trouble free review by other students, a draft version of the seminar paper has to be handed in on a certain deadline announced during the lecture.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Natural and technical basics of energy economics
Energy demand and supply
Energy markets (oil, gas, electricity)
External cost of energy production and the role of renewable energies
Energy policy instruments with special focus on environmental policies (e.g. Pigou tax, emission trading)

Intended Learning Outcomes:
Rising population numbers and increasing living standards boost the worldwide energy demand. Energy producers face the challenge to increase their energy supply and simultaneously reduce negative environmental impacts of energy production. Participants gain a basic understanding of energy demand and supply and of the particularities of energy markets. They will also learn to assess the effects of energy policies on energy markets.

Teaching and Learning Methods:
The first units are dedicated to an introduction to energy economics. In the second part students present the seminar papers of fellow students.

Media:

Reading List:
Erdmann, G., Zweifel, P. (2007) Energieökonomik - Theorie und Anwendungen, Berlin Heidelberg: Springer

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung und Seminar (3 ECTS)
Energiewirtschaftspolitik (LV-Nr. 731322)
2 SWS
Johannes Schmidt

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

Module Description

WZ9455BOK: Biorefinery and Products from Renewable Resources | Bioraffinerie und Produkte aus nachwachsenden Rohstoffen

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	Language: German	Duration: one semester	Frequency: winter semester
Credits:* 2	**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:
written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Biorefinery is a concept towards processing biomass to a variety of products. These products may range from materials, base and fine chemicals, to energy such as gasoline, electrical power or heat. In this lecture the broad range of utilizations of renewable resources are demonstrated, also to introduce main focul points of the german-taught master study "Material and energetic use of renewable resources (NAWARO)" (H 066 471).

Intended Learning Outcomes:
Knowledge on major renewable ressources, including oils, fats, proteins, and carbohydrates. Knowledge on major areas taught in the master study "Material and energetic use of renewable resources (NAWARO)" (H 066 471). Be able to report on different material and energetic uses derived from renewable resources. Ability to give definitions and delineations around "renewable resources".

Teaching and Learning Methods:
class lecture
Introductory lectures by persons who are also engaged with the "Material and energetic use of renewable resources" (NAWARO)" study

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Bioraffinerie und Produkte aus nachwachsenden Rohstoffen (LV-Nr. 970308)
1 SWS
Rupert Wimmer, Alexander Bauer, Sabine Baumgartner, Stefan Böhmdorfer, Andreas Gronauer, Georg Gübitz, Miriam Lettner, Markus Neureiter, Christoph Pfeifer, Tobias Pröll

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

Module Description

WZ9456BOK: Computer Simulation in Energy and Resource Economics | Computer Simulation in Energy and Resource Economics

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
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:
Weekly Assignments (50% of points)
Final oral examination (50% of points)
Extra points in the human-zombie deathmatch

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Bubbles and crashes on energy and resource markets, and complex, non-fully rational human behaviour pose serious problems to traditional economic modeling techniques. This course introduces the students to the concept of complex systems and the method of agent based modeling: both, the concept as well as the method, are highly relevant when trying to explain the above mentioned economic phenomena. This course gives an introduction to complex systems in economics, teaches students how to apply agent based modelling in the context of electricity markets - and tries to shed light on the question how a zombie outbreak may be best survived. Economic agents that show bounded rationality or strategic behavior and markets that are out of equilibrium pose serious problems to traditional economic modeling techniques.

This course introduces the students to the concept of agent based modeling which allows addressing these issues.

After presenting general agent based models in economics, we focus mainly on modeling the design of electricity markets.

Intended Learning Outcomes:
The students learn to understand the concept of complex systems and how the concept may be applied to agent based modeling. They get to know important agent based models from various disciplines (economy, sociology, biology) and learn how to apply them appropriately. Students will also learn how to implement, verify and validate basic agent based models in the programming language NetLogo.

Teaching and Learning Methods:
The course is split into a lecture part which introduces students to the basic theoretical background, a practical part in the computer room, where students learn to program in Netlogo, and weekly assignments for self-study at home.

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Lecture/Seminar (3 ECTS)
Computer simulation in energy and resource economics (LV-Nr. 731369)
2 SWS
Johannes Schmidt

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

Module Description

WZ9457BOK: Modeling of Techno-economical Processes | Modellierung technoökonomischer Prozesse

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 2	**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:
written exam and successful exercise units

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
basic knowledge in computing

Content:
In this course, possibilities for modeling technologically relevant problems within industrial manufacturing processes are elaborated. Multivariate correlations that occur within industrial manufacturing processes, impede the usage of simple analytical software packages. Thus, more sophisticated programs are needed for analyzing increasingly complex problems. In especially, tools for modeling and simulation in MATLAB are presented and applied in the exercising units.

Course structure:
- process analysis (plausibility check of technologically relevant correlations and collected data)
- data acquisition
- data management
- evaluating data quality
- considering time lags (static and dynamic simulation of the material flow)
- model calibration (using multivariate statistical approaches)
- model validation
- model application (prediction of technological properties)
- process adaptation and failure detection

Intended Learning Outcomes:
Students are able to evaluate data quality, detect multivariate correlations, consider time lags using material flows and statistically optimize processes with respect to economically relevant factors.

Teaching and Learning Methods:
Lecture with exercises

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung mit Übung (2 ECTS)
Modellierung Technoökonomischer Prozesse (LV-Nr. 734334)
2 SWS
Martin Riegler

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

Module Description

WZ9458BOK: Silvicultural Strategies for Secondary Conifer Forests | Waldbau in sekundären Nadelwäldern

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 2	**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:
written test on lecture content

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
origin of secondary coniferous forests (Norway spruce, Scots pine, Corsican pine), site characteristics, prospects, problems and risks (e.g., storm damage, snow breakage, pests and deseases, climate change), silvicultural strategies for a sustain able management of secondary coniferous forests (incl. conversion and transformation), prioritization for conversion programs, field trips and case studies.

Intended Learning Outcomes:
Students shall be aquainted with (a) problems of secondary coniferous forests, (b) future perspectives, and (c) silvicultural strategies to manage such forests according to principles of sustainable forest management.

Teaching and Learning Methods:
active participation, seminar exercises, round table discussion

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung und Seminar (2 ECTS)
Waldbau in sekundären Nadelwäldern (LV-Nr. 913319)
1,5 SWS
Manfred Josef Lexer, Eduard Hochbichler

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

Module Description

WZ9459BOK: Regeneration Resources I | Nachwachsende Rohstoffe I

Versio

Reading List:
„Nachwachsende Rohstoffe", Wulf Diepenbrock . UTB-Ulmer, 2014. „Energie aus Biomasse", Martin Kaltschmitt, Hans Hartmann, Hermann Hofbauer. Springer-Verlag, 2009. „Regenerative Energie in Österreich", Martin Kaltschmitt. 2009.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (4 ECTS)
Nachwachsende Rohstoffe I (LV-Nr. 951329)
3 SWS
Eduard Hochbichler, Wulf Diepenbrock, Hans-Peter Kaul, Bano Mehdi

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

Module Description

WZ9460BOK: Life Cycle Assessment of Renewable Resources | Life Cycle Assessment nachwachsender Rohstoffe

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
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:
written exam (60% of the Mark)
two working assignments (40% of the Mark)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Life cycle analysis
Energy efficiency
Environmental performance concept

Intended Learning Outcomes:
To learn about chances, risks and effects of new technologies

Teaching and Learning Methods:
Lecture
Practice with software
Joint preparation of application examples
Independent processing of simple projects

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung mit Übung (4 ECTS)
Life cycle assessment nachwachsender Rohstoffe (LV-Nr. 915326)
3 SWS
Andreas Gronauer; Martin Kühmaier, Gerhard Piringer, Karl Stampfer

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

Module Description

WZ9461BOK: Climate Change and Forest Management | Klimawandel und Waldbewirtschaftung

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
The asssessment is based on the contribution of the students to the discussion, their short presentations of a selected scientific article as well as a written discussion of the text.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
The course is open to all students with a background on ecology and climatology. It is especially tailored for students in their master curricula (e.g., forestry and environmental resource management).

Content:
Climate change is a major challenge to sustainable forest management. Due to the longevity of trees and the resulting long planning horizons accounting for climate change in forest management decisions is necessary already today. The ability to naturally adapt to the expected drastic changes in the climate system are limited in forest ecosystems. Thus adaptive management is of increasing importance. Furthermore, forestry is facing an increasing societal demand on forest services, which are addressed in a paradigm shift from sustainable timber production to a broader view on sustainable forest management.

The course gives an overview over expected climate change impacts in forest ecosystems. With regard to forest management decision support under changing conditions analysis approaches such as integrated assessment and vulnerability are discussed. Spotlights on promising methodological approaches such as ecosystem modelling are provided. Potential and limitations of adaptation measures in forestry are discussed. Furthermore, the potential effect of forests in mitigating climate change (e.g., C sequestration, biomass for bioenergy) is highlighted.

Intended Learning Outcomes:
The overall aim of the course is to review the state-of-the-art with regard to impacts, adaptation and mitigation of climate change in forestry. Global (climatic change) and regional (sustainable provision of multiple forest services) challenges and their interplay are discussed. Using the highly relevant and multi-facetted issue of climate change as an example scientific skills in working with original literature sources and writing scientific essays are promoted.

Teaching and Learning Methods:
Selected topics are presented in short lectures. Papers on the topics will be analysed by the participants and discussed in the group (guided reading). A short written discussion on a selected topic / text will be prepared by the participants.

Media:

Reading List:
Material will be provided in the class and via the BOKU E-Learning platform

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung und Seminar (2 ECTS)
Klimawandel und Waldbewirtschaftung (in Eng.); (LV-Nr. 913331)
2 SWS
Rupert Seidl

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

Module Description

WZ9462BOK: Nature and Landscape Conservation Economics | Naturschutz- und Landschaftsökonomik

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
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:
oral
Oral exam

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Introductory basics:
• origin, knowledge interests and tasks of the landscape and nature conservation economy
• economy as driving force of environment and landscape change
• economic actors and their influence on nature and landscape

Links between economic theory and nature:
• nature and landscape in the conceptual history of economics
• nature and landscape as economic goods – specific characteristics
• landscape conservation and nature conservation as externalities
• monetarisation of the man-made landscape, internalization of landscape stewardship
• concept of multifunctionality and ecosystem services

Evaluatory aspects:
• aims of nature conservation and sustainable landscape development
• assessment of nature conservation and landscape conservation achievements
• model calculations for the performance of nature and landscape conservation

Political action:
• strategies for coping with landscape and nature conservation conflicts
• good governance for landscape and nature conservation
• the role of agriculture and forestry for nature and landscape conservation
• nature conservation and landscape conservation programs and their background

Intended Learning Outcomes:
• create an understanding for economic background of the landscape change and the nature conservation
• develop an ability for integrating sustainability, landscape and physical compatibility aspects in the economic calculation
• mediation of practical application possibilities of environmental-economic theories for land-scape protection and nature conservation

Teaching and Learning Methods:
Didactic preparation:
lecture, discussion, team work, role plays

Media:

Reading List:
No lecture notes are available

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (3 ECTS)
Naturschutz- und Landschaftsökonomik (LV-Nr. 731350)
2 SWS
Hans Karl Wytrzens

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

Module Description

WZ9463BOK: Master's Thesis Seminar | Masterseminar

Version of module description: Gültig ab winterterm 2017/18

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

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

Description of Examination Method:
Participation (80 out of 100) , presenting own results and taking actively part in discussions in the working group's regular seminar.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
ATTENTION:
The Master's Thesis Seminar for the fields of agricultural engineering, livestock sciences and organic farming will be held in separate groups or in some cases jointly.
Information regarding room and time are announced on the blackboard or website of the respective division (www.nas.boku.ac.at).

Instructions in conducting and writing a master thesis.
Assistance in solving problems in this context.
Public presentation and defence of the master thesis among scientists.
The grading of the master thesis is also based on this presentation.

Intended Learning Outcomes:
Ability to conduct and write a scientific work (master thesis) in the fields of agricultural engineering, livestock sciences or organic farming with advisory support.

Teaching and Learning Methods:
Frontal instruction

Introductory lectures from people who are currently taking part in the "Material and Energetic Exploitation of Renewable Raw Materials (NAWARO)" master programme

Frontal instruction introducing the scientific work
Practical work from the scientific lectures as well as specialist discussion
Training on presentation techniques

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar (2 ECTS)
Masterseminar (LV-Nr. 930300)
2
gesamter Lehrkörper, der am Studiengang beteiligt ist

Barta, Norbert , Bauer, Alexander , Freyer, Bernhard , Friedel, Jürgen Kurt , Fürst-Waltl, Birgit , Gronauer, Andreas , Knaus, Wilhelm Friedrich , Kummer, Susanne , Leeb, Christine , Meszaros, Gabor , Piringer, Gerhard , Quendler, Elisabeth , Schunko, Christoph , Sölkner, Johann , Vogl, Christian R. , Winckler, Christoph , Wurzinger, Maria , Zollitsch, Werner
For further information in this module, please click campus.tum.de or here.

Module Description

WZ9464BOK: Experimental Design | Statistische Versuchsplanung

Version of module description: Gültig ab winterterm 2017/18

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

WZ9466BOK: Soil Protection | Soil Protection

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
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:
written and oral
The overall grade is composed of the following components:
Written exam (multiple & single choice) 40%
Homework - Case Study (written) 50%
Participation in the Peer Review Workshop 10%

Grading scheme:
>=90 Excellent (1)
>=80 Good (2)
>=70 Fair / Average (3)
>60 Passed (4)
<=60 Failed (5)
Note: the course certficate can only be issued after all examination parts are passed with at least 50% of the maximum attainable scores.

The blended learning components (homework, peer review workshop) are handled through BOKU Learn.
The written exam (multiple/single choice mode) comprises a total of 10 questions.
Grading will only be issued if all assessment components are passed with at least 50% of the maximum scores attainable.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of soil science (at least bachelor level, ideally the level after passing the exam of 911.306 - Soil Science Refresher); Proficient English

Content:
Introduction
- Global issues and drivers of soil less and degradation (theory/lecture)
-Major soil threats at global, European and national level (theory/lecture)
-Case studies covering different aspects of soil degradation and soil management (blended learning component: homework, peer review workshop)

Intended Learning Outcomes:
Overall aim: Provide an overview on major problems of soil protection and sustainable land use at global, European and national (Austrian) level.
Objectives:
- make you familiar with the main soil threats at global, european and national level
- make you familiar with (sources of) information on the current state of soil
- give you an appreciation of instruments of soil protection and their application to specific problems
- encourage critical evaluation and challenging of current concepts of soil protection
- provide guidance for informed use of soil information and decision making
- enable you to develop possible solutions for better protection of soil
Expected learning outcomes:
- Know and comprehend fundamental soil threats
- Recall the main soil threats
- Know about major drivers and causes of soil degradation
- Put them into context of natural, societal and economic conditions
- Rank their relative importance at national, European and global level
- Know about the state of soil (degradation)
- Recall major pattern of soil degradation at national and European scale
- Know about sources of soil information and their application
- Recall important sources of soil information in Austria, Europe and at global level
- Make informed use of soil information
- Know about instruments / measures of soil protection
-Apply your knowledge to a case study

Teaching and Learning Methods:
Interactive lecture
Interactive lecture (theory part) combined with blended learning components (Homework, peer review workshop) handled through BOKU Learn.

Media:

Reading List:
The course materials will be made available chapter by chapter during the semester through BOKULearn.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (3 ECTS)
Soil protection (in Eng.); (LV-Nr. 911301)
2 SWS
Walter Wenzel

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

Module Description

WZ9467BOK: Mountain Forest Silviculture | Gebirgswaldbau

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 2	**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:
written
written test on lecture contents

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic silvicultural know how as it is taught in the Bachelor class of Silviculture

Content:
Forests are one of the key vegetation forms in Mountainous areas and forest coverage is required to ensure the protection function within this multi-functional environment. Forests fulfill a protection- production- welfare and recreational function and thus help to guarantee the settlement areas in mountainous regions. For example, it is expected that within the State of Tirol only 15 % may be considered as potential settlement area and without forests this area would be much smaller. We have 22% of Mountain forests which grow under extreme conditions (e.g. climate, soil, shortage of the vegetation period, etc.). Thus maintaining forests for ensuring its multifunctional role within Mountainous areas is a key element within silviculture This also underlines that regeneration is extremely important and that potential threats for forest regeneration such as browsing, grazing and entomological risks, etc., need to be avoided. These threats lead to a substantial decline in forest regeneration and thus in a long run to unstable and fragile forests. Forests in mountainous areas require special silvicultural techniques and have to ensure a continuous coverage of the forested area.
This requires an assessment of the risk potential followed by a short, medium and long term planning of silvicultural treatments.

Intended Learning Outcomes:
General understanding of forests in mountainous areas including their role for ensuing the multifunctional demands, required planning activities and silvicultural activities. Why are forests important and what would happen if we would have no forests.

Teaching and Learning Methods:
Lecture in the classroom. Background material will be distributed during the course.

Media:

Reading List:
Hasenauer H.: Skriptum Waldbau; Mayer, H.: Waldbau auf soziologisch-ökologischer Grundlage; Mayer, H. - Pitterle, A.: Osttiroler Gebirgswaldbau

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Gebirgswaldbau (LV-Nr. 913328)
2 SWS
Hubert Hasenauer, Rupert Seidl

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

Module Description

WZ9468BOK: Forest Soil Biology | Waldbodenbiologie

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	Language: German/English	Duration: two semesters	Frequency: winter/summer semester
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:
The participants in these lectures and exercises are constantly evaluated. Criteria for evaluation are regular attendance, quality of contributions, input to discussions and presentation of results.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
(1) Soil sampling for microbial analysis and gas measurement

(2) Lectures on microbial decomposition in the forests, factors of influence, soil organisms, effects of soil warming

Intended Learning Outcomes:
Understanding of the forest soil as a habitat for microorganisms, soil animals and plant roots. View of the reciprocal effects and activities of these organisms, their function and their dependence on the environment.

Teaching and Learning Methods:
lecture with exercises

Media:

Reading List:
Haider K. (1996) Biochemie des Bodens. Ferdinand Enke Verlag, Stuttgart, 174 pp.
Killham K. (1994) Soil Ecology, Cambridge University Press, Cambridge, 141 pp.
Paul, EA, Clark, FE (1996) Soil Microbiology and Biochemistry. Academic Press, New York, 340 pp.
Schlegel, HG (1992) Allgemeine Mikrobiologie. 7. Aufl. Thieme verlag, Stuttgart, 634 pp.
Sylvia D.M., Fuhrmann J.J., Hartel P.G., Zuberer D.A. (1999) Principles and Applications of Soil Microbiology. Prentice Hall, Upper Saddle River, New Jersey, 550 pp.
- A script will be available

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung mit Übung (3 ECTS)
Waldbodenbiologie (in Eng.); (LV-Nr. 911348)
2 SWS
Sophie Zechmeister-Boltenstern

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

Module Description

WZ9469BOK: Aspects of Nature Conservation in Forest Protection | Naturschutzaspekte des Waldschutzes

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
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:
oral

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Possibilities to implement forest protection measures in accordance with nature conservation. Evaluation of forest protection risks in general and of forest protection risks in connection with total retraction from any forest protection measures. Problems related with dying and with dead trees. Modus operandi in special cases: diagnosis of pests and their natural enemies, risk assessment and determination of site predisposition and of stand predisposition.

Intended Learning Outcomes:
Relaying of problem-oriented knowledge for risk assessment in case of execution or of omission of forest protection measures.

Teaching and Learning Methods:
interactive lecture

Media:

Reading List:
Scherzinger W. (1996): Naturschutz im Wald. E. Ulmer

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (1 ECTS)
Naturschutzaspekte des Waldschutzes (LV-Nr. 916327)
1 SWS
Rudolf Wegensteiner

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

Module Description

WZ9470BOK: BOKU: Research Design | BOKU: Research Design

Version of module description: Gültig ab winterterm 2017/18

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 2	**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 Le?

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

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

Module Description

WZ9472BOK:

Version of module description: Gültig ab winterterm 2017/18

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

WZ9473BOK: Actual and Future-oriented Themes of Silviculture | Aktuelle und zukunftsorientierte Themen des Waldbaus

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Presentation and discussion of current and future oriented forest management questions/problems (increasing demand of wood; climate change; continuous cover forestry; etc.); evaluation of possibilites/alternatives, chances and risks of silvicultural concepts and procedures considering changing general conditions/challenges

Intended Learning Outcomes:
Extending of silvicultural knowledges; adaption of competences for developing silvicultural strategies and deducing of objective oriented and situational treatment programmes

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung und Exkursion (2 ECTS)
Aktuelle und zukunftsorientierte Themen des Waldbaus (LV-Nr. 913009)
2 SWS
Eduard Hochbichler

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

Module Description

WZ9474BOK: Agricultural Engineering in Plant Productionseminar | Agricultural Engineering in Plant Productionseminar

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	Language: German/English	Duration: one semester	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:
The overall course grade is compiled from evaluations in the following three areas:
1. Evaluation of active participation during course meetings with mandatory attendance (15 points)
2. Evaluation of the final paper (40 points)
3. Evaluation of the final presentation (45 points)

Grades:
The grades for the course will be calculated according to the number of points achieved and based on the following grading scale:
90 – 100 Points = very good (1)
78 – 89 Points = good (2)
66 – 77 Points = satisfactory (3)
55 – 65 Points = adequate (4)
0 – 54 Points = inadequate (5)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
The prerequisite for participation in the course is a solid foundation in agricultural engineering and agricultural production, as well as in plant production.

Content:
The course focuses on special topics in the field of agricultural engineering in plant production. This course builds upon the content of the courses “Fundamentals of Agricultural Engineering“ (931.103), “Agricultural Engineering in Plant Production“ (931.100) as well as „Agricultural Engineering in Plant Production - practical course“ (931.101). Students will delve

into various aspects of agricultural engineering by researching and writing literature comparison papers. One focus of the course is to work with scientific literature in English and correctly use English technical terms.

The course is designed to be interdisciplinary and covers process engineering (through the detailed examination of process engineering aspects of agricultural engineering), plant production aspects (by conveying the technical requirements based on plant production conditions), as well as sustainability aspects (by evaluating the environmental effects, future viability). The course's primary aim is not simply to communicate detailed information on agricultural engineering, but rather to contribute to a critical evaluation of processes and innovations in the course's areas of focus, as well as to determine problems and challenges in the selected fields of application.

Intended Learning Outcomes:
Upon positive completion of the course, students will be able to:
• Give an overview of special topics in the field of agricultural engineering
• Confidently use scientific literature (search, use and correctly cite literature)
• Critically evaluate scientific literature
• Participate in discussions based on the analysis of scientific literature and determine development potential, risks and open research areas

Teaching and Learning Methods:
The topic of the course paper can be chosen from a pool of topics, however each topic may only be researched once. The topic will be presented and clarified during the last course units.

The content of the course paper will be a critical examination of one technology. The final paper should be structured as follows:
1. A short summary of the technology and its current state of development (ca. 500 words)
2. A summary of the technologies/innovations as described in the literature (ca. 1,000 words)
3. A critical evaluation of innovations (benefits, drawbacks, practical applicability), discussion supported by literature data (ca. 1,000 words)
4. A conclusion (max. 100 words)

The course paper will be written about the individual technologies in 3-person groups. The course paper should be as short and concisely written as possible (no comprehensive "summary" of the literature); the suggested length of the paper is approximately 5-6 pages (2,600 words not counting the bibliography). The course papers should be based on the content of at least 10 scientific publications written in English.

Results of the course paper will be presented visually in the concise format of a poster. Course leaders will make a template for the poster available to all course participants. Upon positive evaluation, posters will be approved for printing.

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar mit Exkursion (4 ECTS)
Agricultural engineering in plant production - seminar (LV Nr. 931300)
3 SWS
Alexander Bauer, Norbert Barta, Andreas Gronauer, Gerhard Piringer, Helmut Wagentristl

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

Module Description

WZ9475BOK: Waste Technology | Entsorgungstechnik

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
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:
Written
The written exam consists of open questions, multiple - choice questions and yes/no questions.
To obtain a positive evaluation it is required to achieve 63% of the maximal achievable points (>/= 15 of 24 points).
You find further scaling of the grades on your exams!

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Details concerning the topics Biological Treatment, Incineration, Incineration Residues, Disposal of Sewage Sludge etc.

Intended Learning Outcomes:
The standard of knowledge and the state-of-the-art of selective fields in waste disposal are communicated

Teaching and Learning Methods:
Class lecture

Media:

Reading List:
Standhartinger K., Chemie für Ahnungslose - Eine Einstiegshilfe für Studierende. Hirzel S. Verlag, Stuttgart, ISBN 9783777613017.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (3 ECTS)
Entsorgungstechnik (LV-Nr. 813339)
3 SWS
Marion Humer-Huber, Erwin Binner, Josef Stubenvoll

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

Module Description

WZ9476BOK: Plant and Environment Technology | Umwelttechnik in der Holzindustrie

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
written test, seminar attendance

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Safety Technique, Industrial Organisation, Economic Industrial Management, Maintenance, Planning of Plants, Structure of Personell, Equipments and Plants for Environmental Protection, Developments regarding Environmental Protection (production-oriented, product-oriented, service-oriented), Environmetal Management EMAS and ISO, Ecological Industrial Balance, Material Flow Balances, Cleaner Production.

Intended Learning Outcomes:
It is the target of the lecture to give an introduction into the problems of development, planning and operation of industrial plants.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung und Seminar (2 ECTS)
Umwelttechnik in der Holzindustrie (LV-Nr. 891349)
2 SWS
Siegfried Pöchtrager, Tobias Pröll, Ena Smidt

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

Module Description

WZ9477BOK:

Version of module description: Gültig ab winterterm 2017/18

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

WZ9478BOK: Water Quality Assessment | Qualitätsbeurteilung von Wasser und Abwasser

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4.5	**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:
written exam

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
none

Content:
How to define goals and formulate concepts for the design of monitoring programmes.
-National and international legal framworks and requirements for the quality evaluation for drinking water, fresh water, waste water and sewage sludge (Codex, AEVO, WHO, EU).
-Substances and microorganisms in water and their relevance from the technical and hygienic point of view.
-Sampling, conservation and analysis of water and waste water in theory and practice.
-Interrelation and interpretation between microbiological and chemical data.
-HACCP-concept, water safety plan, EU-Risk Assessment.
-Practical experiments.

Intended Learning Outcomes:
Theoretical and practical instructions for the generation and interpretation of data, especially for drinking water and waste water; theoretical and practical approach.

Identification of factors which could influence the monitoring and interpretation of data

Teaching and Learning Methods:
Lecture with exercises
Practical chemical and microbiological experiments, excursions.

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung mit Übung (4,5 ECTS)
Qualitätsbeurteilung von Wasser und Abwasser (LV-Nr. 811312)
3 SWS
Maria Fürhacker, Gerhard Lindner, Roza Allabashi, Marija Zunabovic-Pichler

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

Module Description

WZ9481BOK: Global Change Ecology | Globaler Wandel und Ökosysteme

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
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:
written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Overcoming the impact of global, anthropological global changes on organisms and ecosystem will be among our the greatest challenge in the future. In this lecture stuents will learn the theoretical background of the mode of action of selected global changes as greenhouse effect (atmospheric CO_2 concentrations, warming, extreme weather events), ozone hole vs. surface ozone and interactions between these factors. Following, methodological approaches for studying global change effects will be discussed. Then, a state-of-the art of global change ecology in terrestrial ecosystems and their feedback mechanisms will be given. At the end, a critical discussion with students about the presentation of this topic in media will be organised.

Intended Learning Outcomes:
1. Getting to know the most important, anthropogenic global changes.
2. Understanding the mechanisms how organisms and ecosystems respond to global change factors.
3. Knowing experimental and methodological approaches to study past and prospected global changes.
4. Explore key research findings on global change effects on organisms and ecosystems.
5. Critical discussion of scientific and pseudo-scientific publications on this topic.

Teaching and Learning Methods:
multimedia-supported

Media:

Reading List:
will be announced in class

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (3 ECTS)
Globaler Wandel und Ökosysteme
2 SWS
Johann Zaller

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

Module Description

WZ9482BOK: Seminar in Global Change and Ecosystems | Seminar in Global Change and Ecosystems

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
Evaluation of student presentation of a scientific publication.
Evaluation of content and form of presentation; details will be announced in course.
For a successful approbation, max. 2 missing dates will be tolerated.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
This seminar complements and extends the lecture VO 833.318 Global Change and Ecosystems. In the focus will be the following anthropogenic, global changes and their effects on organisms and ecosystem: greenhouse effect (atmospheric CO2 concentrations, warming, extreme weather events), ozone hole vs. surface ozone, increasing nitrogen deposition, land use change, decline in biodiversity, light pollution, noise pollution, plastic pollution, genetically modified organisms, pesticide use. In this seminar topics from the lecture will be complemented and deepened by student presentations. Great emphasis will be given on a critical discussion of the relevant scientific literature.

Intended Learning Outcomes:
1. Learn how to utilize relevant scientific data bases.
2. Critical discussion of scientific literature and knowledge.
3. Improvement of presentation skills.

Teaching and Learning Methods:
Presentation of scientific articles

Media:

Reading List:
wird bekanntgegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar (2 ECTS)
Seminar in global change and ecosystems (in Eng.) (LV-Nr. 833319)
1
Johann Zaller
For further information in this module, please click campus.tum.de or here.

Module Description

WZ9483BOK: BOKU: Biomimetics - Technical Solutions from Nature | BOKU: Bionik - technische Lösungen aus der Natur

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
No specific previous knowledge expected!
COURSE LANGUAGE IS GERMAN!

Content:
The scientific discipline bionics is concerned with the technical implementation & application of construction, processing & development principles of biological systems. Since the beginning of time, we have been learning from Nature. Today, innovation pressure & the necessity to find sustainable, resource efficient & "mature" solutions for questions & problems of our society have tremendously increased. By thorough understanding biologically optimized systems, we can obtain better solution in a faster way, by making millions of years of evolution & selection part of our research & development work.

The lecture „Bionics – technical solutions from Nature" is devoted to the following contents:
- Systematic introduction to the scientific areas of bionics
- Historical & state of the art examples, to understand the methodical approach of bionics
- Development of a fundamental understanding of the functionality of selected biological systems
- Illustration of technical applications in "bionic" products or processes as well as further possible fields of application

The lecture is held in 2 parts:

Part 1: Introduction and bionics in the animal kingdom (H. Lichtenegger)
1. Introduction: pioneers of bionics & their achievements, bionics as science, bionic approach, difference to “pseudobionics”
2. Principle of a bionic invention, example of the Bionic Car
3. Surfaces: to glide or to stick, this is the question. The tricks of sharks, sand fish and geckos, and their application.
4. High performance materials: as hard as nacre, as tough as spider silk or as shiny as a butterfly? The inner structure is key.
5. Self-assembly: principles in Nature and transfer to artificial systems.
6. Flying through the sky, a human accomplishment: what is it to do with bionics today?

Part 2: Bionics from the world of plants (N. Gierlinger)
1. Bionic “classics” from the world of plants
2. Always clean: super-hydrophobic plant surfaces – from the example to the product
3. Well protected and densely packed: Examples from the world of plants
4. Stable light weight constructions, shape optimization and self-repair: what can we learn from trees, grass, lianas & co?
5. Movement in plants as example for technical applications?

Intended Learning Outcomes:
Students graduating from this course have basic knowledge about principles of bionics. They can cite and explain examples of successful bionic applications and have the basic insight necessary for potential transfer of concepts found in nature to technical problems.

Teaching and Learning Methods:
multimedia-supported

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Bionik - technische Lösungen aus der Natur (LV-Nr. 892325)
2 SWS
Notburga Gierlinger, Helga Lichtenegger

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

Module Description

WZ9484BOK: Separation Processes for Renewable Resources | Verfahrenstechnik für Nawaros

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge of Flow Mechanics, Thermodynamics and Heat and Mass Transfer are needed for this course, as they are taught in the lecture "Introduction to Process Engineering"(893.142) of the Bachelor "Wood and Fibre Technology".

Content:
This course gives an introduction to separation processes as destillation, cristallization, drying and extraction.

Intended Learning Outcomes:
Renewable resources are best utilized in a cascade like manner. This means, that first valuable contents as drugs are separated. Than other contents are utilized as products or basic chemicals, materials or fibres and the rest is converted to energy. Separation processes are needed for this need a lot of energy. This course gives an introduction to separation processes as destillation, cristallization, drying and extraction.

Teaching and Learning Methods:
Interactive lecture

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (3 ECTS)
Verfahrenstechnik für NAWAROs (LV-Nr. 893313)
2 SWS
Martin Wendland

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

Module Description

WZ9485BOK: Logistic Systems | Unternehmensnetzwerke (Logistik)

Version of module description: Gültig ab winterterm 2017/18

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:

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

Module Description

WZ9486BOK: Wood and Fibre Quality | Wood and Fibre Quality

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 2	**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:
written and oral
written exam

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
1st lector: Functional cambium and wood formation
1 st lector: Wood, paper and fibre properties of interest, Advanced methods for wood and fibre characterisation
2 nd lector: Within-tree variability, conceptual models
2 nd lector: Wood structure-property relationships
3 rd lector: Links between wood / fibre / paper properties and environmental factors
3 rd lector: Improvement of wood quality, plantation forestry, Wood and fibre quality for wood composites

Intended Learning Outcomes:
Wood and fibres are products of the cambium and it they are based on cells that have passed through various phases of development. This biological process is related to wood and fibre quality, the latter being the arbitrary evaluation of an isolated piece of wood, tree part, piece of paper or any other wood derivative for a certain use. In this respect wood formation is the process, wood and fibre quality and related products are results.

The lecture introduces to basic relationships and that are important to wood and fibres originating from fast-grown plantation, regular managed forests but also from high-elevation sites. The ultimate goal is to understand biological and environmental factors that affect wood and fibre quality as well as advanced wood materials, and how to control property variability.

Teaching and Learning Methods:
multimedia-supported
Powerpoint-based lecture, group discussions, content flexibility depending on interest and interaction dynamics

Media:

Reading List:
Wimmer, R., Downes, G.M., Evans, R., French, J. (2008): Effects of site on fibre, pulp and handsheet properties of Eucalyptus globulus. Annals of Forest Science 65 (6)
Wimmer, R. (2002): Wood anatomical features in tree-rings as indicators of environmental change - a review. Dendrochronologia 20(1-2): 21-36.
Downes, G.M., Wimmer, R., Evans, R. (2002): Understanding wood formation: Gains to

Module Description

WZ9487BOK: Natural-fibre Raw Materials | Naturfaserrohstoffe

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 2	**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:
written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Plant-based fibre materials (wood, annual plants, by-products and waste materials from food industry, agriculture, and bioenergy)
Fibre isolation and production technologies
Fibre structure and properties
Introduction to polymeric matrices and fibre-polymer interactions
Fundamentals of fibre-reinforced polymers

Intended Learning Outcomes:
Knowledge of the most relevant natural fibre raw materials and theri advantages and disadvantages in comparison to non bio-based fibres

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Naturfaserrohstoffe (LV-Nr. 891352)
2 SWS
Wolfgang Gindl-Altmutter

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

Module Description

WZ9488BOK: Chemistry and Technology of Polymers | Polymerchemie und Technologie

Version of module description: Gültig ab winterterm 2017/18

Module Level:	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
written and oral
Oral exam which requires in some cases a written explanation of chemical facts, such as by drawing simple chemical structures or reaction equations. If more than 50% of all questions can be answered correcly without help, the exam will be passed with a positive mark. Correct answers that required substantial support of the examiner will contribute at the extent of 50% only to the amount of correct answers required to pass the exam.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
This lecture addresses students of the master courses „Wood technology and management” and “Material and Energetic Exploitation of Renewable Raw Materials”.
With regard to the material exploitation of wood or isolated biopolymers – either direct, as composites with synthetic organic polymers or after preceding homogeneous or heterogeneous modification – a secure grasp of the basics in polymer chemistry and technology is imperative for both of these courses.
Accompanied by a permanent repetition of the basics of organic chemistry and guided by a motivating interactive demonstration of practice-orientated interrelations as a key towards pleasure in chemical aspects of our daily life, this lecture imparts at the beginning on overview of the history of polymer research, the current state of plastics production and the most relevant synthetic inorganic and organic polymers, and biopolymers. After that the following topics will be introduced and discussed:

General structure, terminology and classification of polymers
Main types of polymerisation reactions – Part 1: Step-growth polymerisation
Polycondensation
Silicic acid and polysiloxanes
Polyaddition (e.g., epoxy resins, polyurethanes)
Main types of polymerisation reactions – Part 2: Chain growth polymerisation
Radical polymerisation
Ionic polymerisations
Coordination polymerisation
Ring opening polymerisations
Nomenclature of polymers
Processing and shaping of polymers
Polymer morphology
Design of polymers with regard to high-temperature stability, resistance towards chemicals, and fire resistance
Ageing of polymers (by chemical, thermal, and photolytic processes, X-ray or electron irradiation)
Stabilization of polymers (primary and secondary antioxidants, UV stabilizers)
Polymer recycling

Intended Learning Outcomes:
This lecture imparts ready-to-use knowledge in the areas of organic chemistry, permanently repeated throughout the entire lecture which always makes the connections between the basic principles of organic chemistry and the synthesis of complex polymers. This lecture furthermore imparts the participant solid knowledge of the impact of the macromolecular architecture of main technical polymers on their properties and the interrelation between structure and nomenclature of polymeric compounds. The participants get in-depth knowledge about current trends of polymer application, types and properties of mass and special plastics, basic principles of the synthesis and processing of technically important thermoplastic and thermo-set plastics, as well as basic knowledge of the application-oriented design of synthetic polymers on the molecular level.
Topics, such as oxidative or light-induced ageing of plastics, stabilization of plastics towards ageing through addition of additives or recycling of plastics will be discussed in a similar way.
The participants of this lecture will be furthermore qualified to recognize independently important interrelationships between structure and nomenclature of polymers, and between structure and properties of polymers.

Teaching and Learning Methods:
Interactive lecture

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Polymerchemie und Technologie (LV-Nr. 774327)
2 SWS
Falk Liebner

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

Module Description

WZ9489BOK: Chemistry and Technology of Sustainable Resources | Chemie und Technologie nachwachsender Rohstoffe

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
written and oral
written (4-5 questions, 60% are required to pass), followed by an oral exam (10 min)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic courses in chemistry

Content:
Monosaccharides, Oligosaccharides, Cellulose, Cellulose derivatives, Starch

Lignin: Basic building blocks, Biosynthesis, Analytical methods for Lignin characterization,

Basic concepts of reactivity (carbohydrates and lignin)

Pulping, Bleaching: General Overview, History of paper making

Chlorine based bleaching, Oxygen based bleaching, bleaching technologies and basic reactions of wood components,

Alternative bleaching methods (LMS, POM, PAA).

Fiber production: Viscose and Tencel process - basic chemical reactions and technological principles, side reactions.

Cellulose Derivatives: cellulose acetate, carboxymethyl cellulose, methyl cellulose - preparation and application

Aging and Degradation: Basic reactions of cellulose degradation, mass-deacidification methods

Intended Learning Outcomes:
Chemistry and basic technology of sustainable resources, mainly based on wood components are covered.

Teaching and Learning Methods:
Class lecture

Media:

Reading List:
Ek et al. (Eds). Pulp and Paper Chemistry and Technology Vol. 1-4, De Gryuter
Fengel and Wegener "Wood"
Klemm et al., "Cellulose and cellulose derivatives"
H. Sixta, Handbook of Pulp
Holik, Handbook of Paper and Board
J. Lehmann, Kohlenhydrate

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Chemie und Technologie nachwachsender Rohstoffe (in Eng.); (LV-Nr. 774301)
2 SWS
Antje Potthast, Thomas Rosenau

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

Module Description

WZ9490BOK: Processes in Enzyme Technology | Processes in Enzyme Technology

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 2	**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:
oral

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
The course will provide an overview of the key enzymes currently used in industrial processes. An overview of the technical use of enzymes and the possibilities to change and improve enzyme performance for adaptation to technical applications including enzyme optimization through enzyme discovery and engineering will be presented. A number of case studies highlighting the use of enzymes in industries e.g., starch conversion, food production, textile, wood fiber processing, biofuel production etc. will be explored.

Intended Learning Outcomes:
After passing the course, the students should be able to:
- understand the fundamentals of catalytic principles, enzyme kinetics and reaction mechanisms,
- explain the key structural factors which give rise to increased enzyme stability important for industrial applications,
- describe methods for selection and optimisation of industrial enzymes using genetic and biochemical techniques,
- describe and evaluate methods for enzyme immobilization and for characterization of the properties of immobilized enzymes

- describe a contemporary application of enzyme technology and present in a well-structured oral presentation.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Processes in enzyme technology (in Eng.); (LV-Nr. 752332)
2 SWS
Thu Ha Nguyen

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

Module Description

WZ9491BOK: Biochemical Technology | Biochemical Technology

Version of module description: Gültig ab winterterm 2017/18

Module Level:	Language: German/English	Duration: two semesters	Frequency: winter/summer semester
Credits:* 2	**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:
written and oral
oral exam dates can be arranged individually
alternative, students can hand in a term paper (approx. length should be 15 pages) on a topic of biochemical technology which must be based on original literature and cover microbiological, biochemical and technological aspects of the production of selected chemicals / industrial products. These topics for the term paper can be selected individually

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in microbiology and biochemistry (main metabolic pathways in micro-organisms) as well as in biotechnology (cultivation of micro-organisms, fermentation technology)

Content:
1. The lecture on 'biochemical Engineering' will give details about the production processes of some of the most important substrates used for fermentative processes or further transformations, starch, sucrose and plant oils. Alternative production of oil through fermentation by yeasts, fungi and algae.
2. Introduction to enzymes, enzyme catalysis and enzymatic processes; use of enzymes to produce glucose syrup from starch; enzymatic systems involved in the degradation of lignocellulose and conversion of lignocellulosic polysaccharides to fermentable sugars, enzymatic esterification in the production of biodiesel
3. fermentation processes to produce ethanol and other alcohols; lactic acid, succinic acid and other building blocks for the chemical industry; use of metabolic engineering to improve these fermentation processes
4. biocatalysis, definition, challenges and major examples

Intended Learning Outcomes:
After completing the course on 'Biochemical Technology' students will have a profound knowledge of important sources for fermentable sugars, enzymatic conversion of various polysaccharides to fermentable sugars, and the production of major chemical building blocks through fermentation and biocatalysis

Teaching and Learning Methods:
multimedia-supported
both the handouts of the course and relevant review articles can be downloaded from the BOKU Learn system after log-in

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Lecture (2 ECTS)
Biochemical technology (LV-Nr. 752340)
2 SWS
Dietmar Haltrich

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

Module Description

WZ9492BOK: Wood Biotechnology | Holzbiotechnologie

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 2	**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:
written exam

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Wood Biotechnology explains the interactions between enzymes and chemistry / ultrastructure of the wood and leads in biotechnology, which is currently in the timber loading and processing used. In addition to the biotechnological development of basic skills will include differents? fungal process? (Biopulping, bioremediation, Biocontrol, improving impregnability wood, fungal cultivation) and? Enzymatic processes? (Grafting, ethanol form wood waste, removal of resin, pulp bleaching, deinking, recycling) discussed

Intended Learning Outcomes:
Consolidated understanding of biotechnological methods for industrial woodworking questions are relevant

Teaching and Learning Methods:
multimedia-supported
both the handouts of the course and relevant review articles can be downloaded from the BOKU Learn system after log-in

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung und Seminar (2 ECTS)
Holzbiotechnologie (LV-Nr. 891339)
2 SWS
Clemens Karl Peterbauer, Erhard Halmschlager, Johannes Tintner

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

Module Description

WZ9493BOK: Economic of Sustainable Land Use under Global Change | Ökonomik Nachhaltiger Landnutzung im Globalen Wandel

Version of module description: Gültig ab winterterm 2017/18

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

WZ9494BOK: Microbiology | Mikrobiologie

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	Language: German	Duration: one semester	Frequency: winter semester
Credits:* 2	**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:
written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
1. INTRODUCTION
History
The microbial cell

2. PHYSIOLOGY AND GROWTH
Nutrients
Catabolism
Anabolism
Growth
Cell division
Growth kinetics
3. INTRODUCTION TO MOLECULAR BIOLOGY
4. GENETIC ENGINEERING
5A. METABOLISM
5B. BIOACTIVE MOLECULES
5C. BIOENERGY
6. MICROBIAL DIVERSITY
7. MICROBIAL ECOLOGY,BIODEGRADATION AND BIOREMEDIATION

8. SELECTED TOPICS
9. MICROBIOLOGY & RENEWABLE RESOURCES
10. SUMMARY

Intended Learning Outcomes:
Knowledge about basics of microbiology together with technical applications with regard to processing of renewable resources

Teaching and Learning Methods:
Class lecture

Media:

Reading List:
Brock Biology of Microorganisms, 13th Edition

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Mikrobiologie (LV-Nr. 970307)
2 SWS
Georg Gübitz

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

Module Description

WZ9495BOK: Mechanical and Thermal Process Technology II | Mechanical and Thermal Process Technology II

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
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:
written and oral

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Lecture in Mechanical and Thermal Process Technology I (LVA 893.122)

Content:
Part A: Modern Separation Processes
1 Modern Extraction Processes
2 Supercritical Fluid Processes (SFE, SFC, RESS, GAS, etc.)
3 Membrane Processes
4 Process Chromatography ´ Preparative Chromatography

Part B: Reaction Technology
5 Chemical Equilibria
6 Reaction Kinetics
7 Chemical Reactors
8 Residence Time

Part C. Process Integration
9 Design of Plants, Flow Sheets, Environmental Aspects, and Economy

Intended Learning Outcomes:
Based on the lecture Mechanical and Thermal Process Technology II (LVA 893.300), modern seperation processes which are of increasing importance for food and biotechnology are treated more thoroughly. Additionally, the very important subject of chemical reaction technology is treated systematically starting from basic knowledge of reaction equilibria and kinetics and moving to the design of reactors. Finally, it is shown how the knowledge of single unit operations can be integrated to full processes.

Teaching and Learning Methods:
Lecture with exercises

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung mit Übung (3 ECTS)
Mechanical and thermal process technology II (in Eng.); (LV-Nr. 893303)
3 SWS
Senad Novalin, Martin Wendland, Rafat Al Afif

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

Module Description

WZ9496BOK: Wood-Industrial Processes: Wood- and Fibre-based Materials | Wood-Industrial Processes: Wood- and Fibre-based Materials

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
oral

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Wood-based composites (Holzwerkstoffe); first lecture will be a recapitulation.

Content:
Current Topics in Development of wood-based composites materials
Recovered Wood in wood-based composites materials
Recycling of wood-based composites materials
Testing of wood-based composites materials

1 Introduction, wood-based composites overview, trends
2 Special wood-based materials: hardboards
3 Special wood-based materials: particle-based materials
4 Hydrolysation of adhesives / bonding agents
5 Binderless boards
6 Alternative raw materials
7 Alternative raw materials
8 Wood plastic composites - trends and materials
9 Wood quality, species and species mixtures in WBC
10 Biorefinery
11 Process analysis
12 Process analysis

Module Description

WZ9497BOK: Engineered Wood Products | Engineered Wood Products

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 2	**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:
written and oral
oral exam

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Material engineering
Material properties of wood composite components
Beam elements (GLT, LVL, LSL, PSL, I-Joist)
Structural plate elements (OSB, Flakeboard, Plywood)
Non-structural plate elements (Particleboard, MDF, Hardboards)
Wood composite materials

Intended Learning Outcomes:
Students have basic knowledge of the properties of materials used for wood composites
Students know to manipulate or engineer the properties of engineered materials
Students have an overview of existing engineered wood products and their properties, the origin of these properties as well as their main application fields.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Engineered wood products (in Eng.); (LV-Nr.891334)
2 SWS
Johannes Konnerth

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

Module Description

WZ9498BOK: Composite | Composite

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 2	**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:
written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
It is expected that students intending to take the exam in this lecture are familiar with the lectures 'Naturfasern', 'Holzphysik', and 'Naturfaserwerkstoffe und Technologien'.

Content:
Introduction to composite materials, with a strong focus on mechanical properties at micro and macro scale, and the behaviour of lignocellulosic fibres as reinforcements in polymers will be addressed.

Intended Learning Outcomes:
The lecture aims to provide a basic understanding of composite materials and the peculiar properties of bio-based composites.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Composite (in Eng.) (LV-Nr. 891333)
2 SWS
Wolfgang Gindl-Altmutter

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

Module Description

WZ9499BOK: Wood and Fibre Material Performance | Charakterisierung von Holz und Faserwerkstoffen

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** two semesters	**Frequency:** summer semester
Credits:* 2	**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:
oral and written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Compounding, physico-mechanical characterisation, thermoanalysis, berst measurements, rheology

Intended Learning Outcomes:
Get acquainted with chemical, thermal, physical and mechanical methods to characterize natural fibres, natural-fibre materials, wood plastic composites, and polymer materials. Discussion of the theoretical background of different methods, and performing practical exercises and tests using actual materials.

Lectures and some practicals take place in the Schwackhöferhaus, Institut für Holzforschung, Besprechungsraum.

Labs take place at IFA Tulln, Institut für Naturstofftechnik; TU Wien, Inst. für Mechanik der Werkstoffe und Strukturen; and Institut für Holzforschung.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung mit Übung (2 ECTS)
Charakterisierung von Holz- und Faserwerkstoffen (LV-Nr. 891337)
2 SWS
Johannes Konnerth, Notburga Gierlinger, Gerhard Sinn

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

Module Description

WZ9500BOK: Wood Cutting, Milling, Moulding | Zerspanungs- und Formgebungstechnik

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
no

Content:
Basics of wood machining, Wood plastic composites, compounding, extrusion technology, injection molding etc.

Part Sinn:
Fundamentals of machining, cutting materials and cutting optimization of cutting tools.
Chipless forming techniques of wood. Wood-plastic compounds and methods, extrusion and injection molding techniques

Part Müller:
In the lecture part molding technique, in the industry commonly used manufacturing processes for molding technique (excl. Cutting shaping and Formgebund by injection molding and extrusion) will be presented. The idea of the manufacturing process follows the classification featured in the DIN. Also methods outside wood and fobre technologies will be discussed (primarly metalworking).
For the Wood and Fibre technology manufacturing process for the original forms (press technology), the deformation (compression, bending, upsetting) and joining (laminating, layer glueing, etc.) will be discussed.

The three groups of potential shaping of wood and natural fiber materials will be discussed from a technological and material science point of view.

Part Mundigler:
- Introduction: definitions, reasons for use, overview of the market situation
- Biotechnological processes for the production of bio-based polymer materials or bio-based monomers as starting materials: Fermentation raw materials and their availability, microbiological and procedural foundations; biotechnological production of selected products (PHAs, lactic acid and PLA, succinate / PBS and butanediol, 1,3 propanediol and PTT, Biopolyethylen, ...)
- Processing and shaping: Chemical derivatization / synthesis; Shaping (particularly thermoplastic shaping processes); Examples of processing processes in practice
- Characterization of the material properties: structures and microstructure; mechanical properties and related analytical and measurement methods (heat resistance, dimensional stability, ...)
- Biodegradation and disposal: Material properties regarding degradability; Reduction; Certification and labeling; Analytics; Ecology; Legal framework (recognition, approval, disposal technologies)

Intended Learning Outcomes:
Based on the knowledge of wood machining and tools and wood technologies, basic knowlegde on the wood machining process is provided. The second part of the lecuture deals with formgiving technologies derived from plastic industries such as extrusion an injection molding.

Teaching and Learning Methods:
Powerpoint-based lecture, group discussions, content flexibility depending on interest and interaction dynamics

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Zerspanungs- und Formgebungstechnik (LV-Nr. 891328)
2 SWS
Gerhard Sinn, Ulrich Müller, Norbert Mudigler

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

Module Description

WZ9513BOK: Energy Engineering | Energy Engineering

Version of module description: Gültig ab winterterm 2017/18

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

WZ9514BOK: Electrical Power Engineering | Elektrische Energietechnik

Version of module description: Gültig ab winterterm 2017/18

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

WZ9516BOK: Renewable Energy Resources | Renewable Energy Resources

Version of module description: Gültig ab winterterm 2017/18

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

WZ9517BOK: Applied Measurement and Control Systems | Applied Measurement and Control Systems

Version of module description: Gültig ab winterterm 2017/18

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

WZ9518BOK: Practical Course in Energy Engineering | Practical Course in Energy Engineering

Version of module description: Gültig ab winterterm 2017/18

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

WZ9519BOK:

Version of module description: Gültig ab winterterm 2017/18

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

WZ9520BOK: Future energy supply in dependence of resource availability | Zukünftige Energieversorgung in Abhängigkeit der Ressourcenverfügbarkeit

Version of module description: Gültig ab winterterm 2017/18

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

WZ9521BOK: Environmental Economics at Company Level | Betriebliche Umweltökonomie

Version of module description: Gültig ab summerterm 2017

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

WZ9522BOK: Farm Business Management I | Landwirtschaftliche Betriebswirtschaftslehre I

Version of module description: Gültig ab winterterm 2017/18

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

WZ9523BOK: Seminar on Energy Economics | Energiewirtschaftliches Seminar

Version of module description: Gültig ab winterterm 2017/18

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

WZ9524BOK: Market Research and Market Analysis | Marktforschung und Marktanalyse

Version of module description: Gültig ab summerterm 2017

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:

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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

WZ9526BOK: Logistics in forestry and timber industry | Logistik in der Forst- und Holzwirtschaft

Version of module description: Gültig ab winterterm 2017/18

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.

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