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

Module Catalog

M.Sc. Technology of Biogenic Resources

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 course of study.
Serving the goal of transparency in higher education, it provides students, potential students and other internal and external parties with information on the content of individual modules, the goals of academic qualification targeted in each module, as well as their qualitative and quantitative requirements.

Notes to the reader:

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

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

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

Index of module handbook descriptions (SPO tree)

Alphabetical index can be found on page 126

Compulsory Courses | Pflichtmodule

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:
Broder Rühmann

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die stoffliche Nutzung / Renewables Utilization (Exercise) (Übung, 2 SWS)
Rühmann B

Einführung in die stoffliche Nutzung / 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

CS0132: Energy Process Engineering | Energy Process Engineering [EVT]

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:
Matthias Gaderer gaderer@tum.de

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

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:
Prof. Matthias Gaderer

Courses (Type of course, Weekly hours per semester), Instructor:
Mechanical process engineering (Exercise) (Übung, 2 SWS)
Gaderer M [L], Herdzik S

Mechanical process engineering (Lecture) (Vorlesung, 2 SWS)
Gaderer M [L], Herdzik S
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 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:
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:
Next semester

(Recommended) Prerequisites:
none

Content:
Basics of cenceptual design of (bio)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 as well as biotechnological processes 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:

Responsible for Module:
Jakob Burger burger@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Conceptual Process Design (Lecture) (Vorlesung, 2 SWS)
Burger J [L], Burger J

Conceptual Process Design (Exercise) (Übung, 2 SWS)
Burger J [L], Burger J, Rosen N
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)
Gaderer M [L], Chen Y, Herdzik S, Huber B, Klüh D, Naumann G, Putra L, Schropp E, Weiker S
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:
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.

Electives | Wahlmodule

Technical Electives | Fachspezifische Wahlmodule

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

CS0003: Production of Renewable Fuels | Production of Renewable Fuels

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 learning results are going to be proven in form of a written exam of 60 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:
Next 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 (Lecture, Straubing) (Vorlesung, 2 SWS)
Burger J [L], Burger J

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

Production of renewable fuels (Tutorial, Garching) (Übung, 2 SWS)
Burger J [L], Burger J, Rosen N

Production of renewable fuels (Tutorial, Straubing) (Übung, 2 SWS)
Burger J [L], Burger J, Rosen N
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 winterterm 2019/20

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 machine learning 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:
Next semester

(Recommended) Prerequisites:
Basic Mathematical Skills, Basic Programming Skills

Content:
Technologies that generate analyses or predictions based on data can be found in almost all areas of our daily live (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. to predict 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 on various real-world problems.
The following contents will be treated exemplarily:
• Similarity and Distance Metrics
• Data Preprocessing and Visualization
• Classification
o Nearest-Neighbor
o Perceptron & Adaline
o Logistic Regression
o Decision Tree

o Support Vector Machines (SVM)
o Artificial Neuronal Networks
• Model Selection and Hyperparameter Optimization
o Confusion Matrix and Evaluation Measures
o Cross-Validation
o Line Search
o Over- vs. Underfitting
• Clustering
o K-Means
o Hierarchical Clustering
• Regression Models
o Linear Regression
o Support Vector Regression

Intended Learning Outcomes:
The students know the fundamental and most important artifical 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.

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:
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

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

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
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 consists of a written examination and/or 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

CS0092: Wind Power | Windkraft [Wind]

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German/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). 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:
Erich Hau: Windkraftanlagen. Springer, 2008. ISBN 978-3-540-72150-5

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

CS0100: Microbial and Plant Biotechnology | Microbial and Plant Biotechnology [MPBioTech]

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:
In order to check whether students have understood and are able to apply the principles and relevant methods and techniques of microbial biotechnological production processes, the students answer questions about production processes and fermentation strategies in a written exam (90 min, 50% weighting) and prove that they have understood the correlations of microbial metabolism. Allowed tools are calculators. The learning results in the field of plant biotechnology are going to be proved in form of a written exam (60 min., 50% weighting) . In this written exam 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. The seminar talk (20 Min., ungraded) will be evaluated to assess the ability of the students to correctly summarize the content of a complex scientific publication in the field of plant biotechnology and to comprehensively and convincingly present it to an audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals of Biology or of cell and microbiology from the Bachelor's courses

Content:
Relevant topics and techniques of microbial biotechnology: - 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. 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. Current topics will be discussed based on selected original publications. Some of the topics to be discussed: legal

framework, major appication of current plant genetic engineering, the Arabidopsis model system, novel concepts for yield and quality improvement.

Intended Learning Outcomes:
Upon successfull completion of the module, students will be familiar with the principles and techniques of relevant 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 and to calculate mass balances. The students have acquired in-depth knowledge of relevant production processes for selected products of industrial biotechnology. 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. Seminar: recent publications well be selected and briefely discussed with the students, then presented by the students. The presentation will be discussed and evaluated.

Media:
PowerPoint, whiteboard

Reading List:

Responsible for Module:
Bastian Blombach bastian.blombach@tum.de

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

CS0105: Modelling and Optimization of Energy Systems | Modelling and Optimization of Energy Systems [MOES]

Version of module description: Gültig ab winterterm 2020/21

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:
Next 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:

Responsible for Module:
Josef Kainz

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

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
- Individulal 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

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:
Jakob Burger burger@tum.de Matthias Gaderer gaderer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Research Lab Energy and Process Engineering (Praktikum, 5 SWS)
Gaderer M [L], Gaderer M (Burger J, Kainz J), Herdzik S, Klüh D, Köstler M, Schropp E, Weiker S
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

CS0142: Detail Process Engineering | Detail Process Engineering [DPP]

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:
The examination is provided in the form of a term paper and a written exam (90 minutes).
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 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4	**Total Hours:** 10	**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 characteristics of various types of plants for the use of hydropower are assessed in a written examination (60 minutes). Further students shall show the understanding of planning, erecting and operating water power stations.

Repeat Examination:
Next 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 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. Students understand the processes involved in planning, erecting and operating

water power stations and are in a position to analyze plants from an economic and ecological perspective.

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:
Josef Kainz josef.kainz@hswt.de Christoph Pfeffer c.pfeffer@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

CS0147: Energy Efficient Buildings | Energy Efficient Buildings [EEB]

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The module examination takes the form of a project work (report with a length of 15 pages and presentation of results with a length of 20 minutes). The final grade is calculated based on the individual grades from the presentation and report with a ratio of 1:1. The project work is used to check the extent to which the students can independently apply the aspects of energy-efficient buildings to one or more practical examples. A presentation shows whether the students can present their analyses of the energy efficiency of buildings in a comprehensible, precise and clear manner and at the same time can present themselves convincingly and professionally with rhetorical proficiency.

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:
Prof. Thomas Vienken thomas.vienken@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

CS0228: Technology and Management of Renewable Energies in Africa and the EU | Technology and Management of Renewable Energies in Africa and the EU [REAE]

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 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 (30 minutes) and a short report of the students' project work. 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 Africa or in the EU. 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 country context. The presentation will be passed over to the lectureres as well as the short report and will be included in the grading.

Repeat Examination:
Next 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

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 in the EU and in Africa (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 in the EU and in Africa. Thereby 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 a country of the EU or in Africa into account when analysing and elaborating solutions for the question on-hand. They are able to apply their knowledge to create an oral presentation. 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 (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:
Prof. Dr. 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

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:
Prof. Dr. Rubén D. Costa Dr. Julio Fernandez-Cestau Dr. Juan Pablo Fuenzalida Werner

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Electronic Spectroscopy (Lecture) (Vorlesung, 2 SWS)
Costa Riquelme R [L], Costa Riquelme R, Fernandez Cestau J, Fuenzalida Werner J, Nieddu M

Advanced Electronic Spectroscopy (Exercise) (Übung, 2 SWS)
Costa Riquelme R [L], Costa Riquelme R, Fernandez Cestau J, Fuenzalida Werner J, Nieddu M
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 2022

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 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:
Basic knowledge in Machine Learning and Bioinformatics (e.g. Bioinformatics (WZ1631) and Artificial Intelligence for Biotechnology (CS0012))

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
o Basic concept
o Feedforward neural networks
o Recurrent Neural Networks
o Convolutional Neural Networks
o Generative Models
- Genome-wide Association Studies

- Phenotype Prediction
- Protein-Protein Interaction Network Analysis
- Protein Prediction
- Data Driven Biotechnology

After these 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.

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

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

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**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:
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

CS0265: Biorefinery | Biorefinery [BioRaff]

Version of module description: Gültig ab winterterm 2022/23

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 coursework, 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. Bonus points 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;
description of different biorefinery systems (e.g. green biorefinery, lignocellulose biorefinery);
selected procedures for the extraction of resources (focused on lignocellulose);
components of plants and raw material important 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 a biorefinery. 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:
Doris Schieder (doris.schieder@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Biorefinery (Lecture) (Vorlesung, 2 SWS)
Schieder D

Biorefinery (Seminar) (Übung, 1 SWS)
Schieder D
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 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:
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:

(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:
Ben A. Johnson

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

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

WZ1193: Biogas Technology | Biogastechnologie

Version of module description: Gültig ab summerterm 2022

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

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; 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 (e.g. feeding power by a motor, gas supply) and understand their advantages and disadvantages. 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

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:
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

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:
Energy Storage (Lecture) (Vorlesung, 2 SWS)
Gaderer M [L], Chen Y, Weiker S

Energy Storage (Exercise) (Übung, 2 SWS)
Gaderer M [L], Weiker S, Chen Y
For further information in this module, please click campus.tum.de or here.

Biogenic Polymers | Biogenic Polymers

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:
Cordt Zollfrank

Courses (Type of course, Weekly hours per semester), Instructor:
Biogenic Polymers (Lecture) (Vorlesung, 2 SWS)
Zollfrank C [L], Zollfrank C

Biogenic Polymers (Seminar) (Seminar, 1 SWS)
Zollfrank C [L], Zollfrank C
For further information in this module, please click campus.tum.de or here.

Energy and Economics | Energy and Economics

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:
Matthias Gaderer gaderer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Energy and Economics (Exercise) (Übung, 1 SWS)
Gaderer M [L], Naumann G, Schropp E

Energy and Economics (Lecture) (Vorlesung, 3 SWS)
Gaderer M [L], Naumann G, Schropp E
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:
Energy and Economics (Lecture) (Vorlesung, 3 SWS)
Gaderer M [L], Naumann G, Schropp E

Energy and Economics (Exercise) (Übung, 1 SWS)
Gaderer M [L], Naumann G, Schropp E
For further information in this module, please click campus.tum.de or here.

Geothermal Energy Systems | Geothermal Energy Systems

Module Description

CS0263: Geothermal Energy Systems | Geothermal Energy Systems

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**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:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Prof. Thomas Vienken

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.

Polymer Processing | Polymer Processing

Module Description

CS0264: Polymer Processing | Polymer Processing

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**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:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Prof. Cordt Zollfrank

Courses (Type of course, Weekly hours per semester), Instructor:
Polymer Processing (Lecture) (Vorlesung, 2 SWS)
Zollfrank C

Polymer Processing (Practical) (Praktikum, 1 SWS)
Zollfrank C
For further information in this module, please click campus.tum.de or here.

Interdisciplinary Electives | Fachübergreifende Wahlmodule

Module Description

CS0111: Advanced Development Economics | Advanced Development Economics

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:
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:
Next 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 seminar will be done by PowerPoint. In addition, current examples from newspapers and journals will be integrated into the lectures. In the seminar, 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:
Anja Faße

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Development Economics (Tutorial) (Übung, 2 SWS)
Faße A [L], Faße A

Advanced Development Economics (Lecture) (Vorlesung, 2 SWS)
Faße A [L], Faße A
For further information in this module, please click campus.tum.de or here.

Module Description

CLA11317: Interdisciplinary Lecture Series Environment: Politics and Society | Ringvorlesung Umwelt: Politik und Gesellschaft

Version of module description: Gültig ab summerterm 2015

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

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

Description of Examination Method:
A successful accomplishment of 9 academic performances is mandatory for the examination! The examination consists of a short PowerPoint presentation at the end of the semester. The presentation can be created alone or in groups of two. Everyone has to speak one minute. The examination is ungraded.

Repeat Examination:

(Recommended) Prerequisites:

Content:
The lecture series Umwelt (environment) is an interdisciplinary, public lecture organised by the Environmental Department of the Studentische Vertretung (Student Representatives) of the TU Munich. Experts speak e.g. on technical environmental protection, health, consumer and climate protection. In the summer semester, it offers students the opportunity to learn about the political and social dimensions of current ecological topics and research results at a scientific level.

The lecture series Umwelt (environment) is offered in the winter semester in the module CLA11200 Ringvorlesung Umwelt: Ökologie und Technik (Lecture series on the environment: ecology and technology). It is only possible to gain given credits twice for the lecture series within each study program.

Intended Learning Outcomes:
Students are able to follow expert presentations on political and social dimensions of environmental problems and identify core theses and central facts.

Teaching and Learning Methods:
Lectures, presentations, discussions

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Overcoming Obstacles - the Bumpy Road toward Carbon Neutrality (Ringvorlesung Umwelt) - Garching (Vorlesung mit integrierten Übungen, 1,5 SWS)
Fahmy M, Kopp-Gebauer B, Recknagel F, Slanitz A, Zimmermann P
For further information in this module, please click campus.tum.de or here.

Module Description

CLA31900: Lecture Series Environment - TUM | Vortragsreihe Umwelt - TUM

Version of module description: Gültig ab winterterm 2019/20

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 67	**Contact Hours:** 23

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

Description of Examination Method:
The examination consists of a poster created in a group of 2-3 people connecting topics from at least two lectures. In order to collect material for the poster, participants have to organize themselves in discussion groups with 5-6 people.
Each discussion group will split into two groupes for the poster. At the end of the semester the poster has to be presented. Every member of the poster group has to speak one minute,
The grade will consist of the poster and its presentation.
Mandatory requirements for the examination
For the 3-ECTS course a successful accomplishment of 16 academic performances is mandatory for the examination!

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The systematic integration of education for sustainable development at the university is an extremely complex challenge that can only be addressed through a plural and multi-perspective approach. Within the framework of the UNESCO World Programme of Action "Bildung für Nachhaltige Entwicklung“ (BNE; =Education for Sustainable Development), the interdisciplinary lecture series Umwelt - TUM takes place at the TUM Campus Garching, which deals with changing topics in the field of environmental sustainability.

It is organized by the newly founded branch of the environmental department AStA TUM at the Garching campus to promote sustainability awareness at TUM and to offer interested students the opportunity to deal with the topic in more detail.

Intended Learning Outcomes:
After successful participation in this module, students are able to understand lectures at a high scientific level and reproduce central statements. Students are able to comprehend analyses of sustainable development and are familiar with formulating their own positions and justifying them in discussions. Furthermore, they know where they can explore the topic of sustainability in more detail on campus, whether in the form of course offerings, internships, projects or thesis.

Teaching and Learning Methods:
It consists of six lectures and an organizational meeting at the beginning. Each lecture includes two 40-minute presentations, a 15-minute break and a subsequent 45-minute discussion with the speakers, which is realized in cooperation with the Zentrum for Schlüsselkompetenzen (Center for Key Competencies) of the Faculty of Mechanical Engineering.
The lectures and presentation slides will be uploaded to the online learning platform Moodle.
As homework, students will prepare a short report of the lectures and the discussion session. In addition, introductory and further literature will be addressed to enhance more detailed discussions of the lectures.

Media:

Reading List:

Responsible for Module:
Dr. phil. Alfred Slanitz (WTG@MCTS)

Courses (Type of course, Weekly hours per semester), Instructor:
Overcoming Obstacles - the Bumpy Road toward Carbon Neutrality (Ringvorlesung Umwelt) - Garching (Vorlesung mit integrierten Übungen, 1,5 SWS)
Fahmy M, Kopp-Gebauer B, Recknagel F, Slanitz A, Zimmermann P
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 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:
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:
Next 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:
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

CS0102: Introduction to Game Theory | Introduction to Game Theory [IGT]

Version of module description: Gültig ab winterterm 2021/22

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:
Assessment takes an oral form (25 minutes). Students show the extent to which they have understood the taught definitions and terminology from the area of cooperative and non-cooperative games. 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. Students demonstrate their understanding of these solution concepts when answering comprehension questions concerning their properties and the advantages and disadcantages of the different concepts.

Repeat Examination:
Next 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

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 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:
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

CS0177: Discrete Event Simulation | Discrete Event Simulation

Version of module description: Gültig ab winterterm 2021/22

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:
Next 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)
Hübner A [L], Schäfer F

Discrete Event Simulation (Exercise) (Übung, 2 SWS)
Hübner A [L], Tuma N
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 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:
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:
Next 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

SZ0303: German as a Foreign Language A2.1 | Deutsch als Fremdsprache A2.1

Version of module description: Gültig ab summerterm 2022

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

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe A1.2; Einstufungstest mit Ergebnis A2.1

Content:
In diesem Modul werden Grundkenntnisse in Deutsch als Fremdsprache unter Berücksichtigung interkultureller und landeskundlicher Aspekte vermittelt, die es den Studierenden ermöglichen, sich in einfachen, routinemäßigen Situationen zurechtzufinden, z.B. auf Reisen, beim Arzt, auf Wohnungssuche, im Kaufhaus, unter Kollegen, Freunden und Nachbarn.
Sie lernen/üben Vokabular/Ausdrucksmöglichkeiten zu Themen wie Studium und Ausbildung, Beruf, Wohnen, Medien und Reisen. Sie lernen/üben, einfach strukturierte Haupt- und Nebensätze (z.B. dass, weil, und, denn, etc.) zu benutzen, im Präteritum (Modalverben) und Perfekt zu

berichten, den Gebrauch des Komparativ und Superlativ und die Deklination des Adjektivs. Sie wiederholen und erweitern den Gebrauch der Präpositionen im Akkusativ und Dativ.
Es werden Möglichkeiten aufgezeigt, den Lernprozess eigenverantwortlich effektiver zu gestalten und damit die eigene Lernfähigkeit zu verbessern. Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A2 des GER
Nach Abschluss dieses Moduls sind die Studierenden in der Lage im Gespräch einfache Sätze und Redewendungen zu einem erweiterten Spektrum an vertrauten Themen zu verstehen und gebrauchen. Dabei handelt es sich um grundlegende Informationen zu alltäglichen oder studien- bzw. berufsrelevanten Themen unter Einbeziehung landeskundlicher Aspekte.
Sie können beispielsweise sich und andere Personen, persönliche Wohnsituation, Gesundheitszustand, Freizeitverhalten und berufliche Situation beschreiben.
Die Studierenden können längere Texte und Briefe zu vertrauten Themen verstehen, in denen gängige aber einfache alltags- oder berufsbezogene Sprache verwendet wird und in denen vorhersehbare Informationen zu finden sind. Sie können kurze, informative Texte oder Mitteilungen zu grundlegenden Situationen in Alltag und Studium zu verfassen.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese, Schreib- und Sprechübungen erarbeitet werden. Durch die Kombination dieser Übungen in Einzel-, Partner- und Gruppenarbeit wird der kommunikative und handlungsorientierte Ansatz umgesetzt. Durch kontrolliertes Selbstlernen grundlegender grammatischer Phänomene und Kommunikationsmuster in der Fremdsprache mit vorgegebenen (online-) Materialien werden die im Seminar vermittelten Grundlagen vertieft.
Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A2.1 (Seminar, 4 SWS)
Aßmann J, Bauer G, Dechant S, Gemaljevic J, Hanke C, Keza I, Kouhi S, Kummer-Rock A, Kutschker T, Meuschel G, Nierhoff-King B, Stiebeler H
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0414: English - Intercultural Communication C1 | Englisch - Intercultural Communication C1

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
Performance, testing the learning outcomes specified in the module description, is examined by a cumulative portfolio of competence and action-oriented tasks consisting of: A classroom presentation (including a handout and visual aids) (50%) and a final exam (50%). In the presentations and final exam students demonstrate a critical awareness of various dimensions and theories of cultural difference and show that they can apply them in situations where intercultural communication occurs.

Repeat Examination:

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

Content:
This course, taught in English, should familiarize you with some dimensions of cultural variation and theories of culture and communication. While learning to understand and appreciate cultural difference, you will improve your ability to communicate effectively in a global context.

Intended Learning Outcomes:
After completion of this module, students will be able to communicate more effectively with partners from other cultures. Specifically, they can recognize cultural differences when they occur, understand some specific ways in which cultures can differ, and have developed self-awareness of their own cultural behaviors and values, which will help them be more effective in cross-cultural communication situations.

Teaching and Learning Methods:
Communicative and skills oriented treatment of topics with use of group discussion, case studies, presentations, writing workshops, listening exercises, and pair work to encourage active use of language, and provide opportunities for ongoing feedback.

Media:
Textbook, use of online learning platform, presentations, film viewings, podcasts and audio practice.

Reading List:
Handouts and selected extracts from published sources will be used in the course. Key literature will be advised by the teacher and/ or listed in the course description.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - Intercultural Communication C1 (Seminar, 2 SWS)
Hughes K
For further information in this module, please click campus.tum.de or here.

Module Description

SZ04311: English - Basic English for Academic Purposes B2 | Englisch - Basic English for Academic Purposes B2

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
Performance, testing the learning outcomes specified in the module description, is examined by a cumulative portfolio of competence and action-oriented tasks including: Two/three written assignments for a total of 60% (based on multiple drafts to encourage learning by means of revision) in which students are able to produce clear, detailed text on a topic related to their fields of study and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options; a presentation (including a handout and visual aids, 20%) in which oral fluency is demonstrated and an ability to conduct technical discussions in their fields of specialization; a final written examination (20%) in which they demonstrate that they understand the main ideas of complex text in their field on both concrete and abstract topics, including technical discussions, and can express their opinions using a wide range of grammatical structures and collocations accurately.

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

Repeat Examination:

(Recommended) Prerequisites:
Ability to begin work at the B2 level of the GER as evidenced score in the range of 40 – 60 percent on the placement test at www.moodle.tum.de. (Please check current announcements as the exact percentages may vary each semester.)

Content:
This course includes practice with note-taking, practising tutorial participation, academic writing and presenting a topic on a related field of study. Common verb forms such as present simple vs continuous, future forms, present perfect and past simple as well as conditionals will be reviewed and practiced. Other grammatical structures covered include: modal verbs of likelihood, comparatives and superlatives and uses of articles. Oral and written communication skills needed in academic life will be introduced and practiced, as well as aspects of intercultural communication needed for achieving professional success. Emphasis is placed on developing strategies for continued learning.

Intended Learning Outcomes:
On completion of this module students will have gained some of the study skills required for participating in an English-speaking academic environment. Students are able to produce some academic level work in degree courses held in English. They can understand the main ideas of complex text on both concrete and abstract topics, including technical discussions in their fields of specialization; they can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party; they can produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.

Corresponds to B2 of the CER.

Teaching and Learning Methods:
This course involves practising study situations (participating in seminars, tutorials, note-taking), communicative and skills-oriented treatment of topics with use of group discussion, case studies, presentations, writing workshops, listening exercises, and pair work encourage active use of language, as well as opportunities for feedback.

Media:
Texts from a variety of sources, presentations, videos and listening practice.

Reading List:
Handouts and selected extracts from published sources will be used in the course. Key literature will be advised by the teacher and/ or listed in the course description.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - Basic English for Academic Purposes B2 (Seminar, 2 SWS)
Bhar A, Lemaire E, Schenk T, Xu M
For further information in this module, please click campus.tum.de or here.

Module Description

SZ1202: Spanish A2.1 | Spanisch A2.1

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** Language taught	**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:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhalten Aufgaben zur Rezeption (Lese- und Hörverstehen) sowie zur Produktion (Wortschatz und Grammatik sowie freie Textproduktion) und werden in Form von kommunikativen kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben abgehalten. Hilfsmittel erlaubt. Mündliche Produktion wird anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei abgehalten. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Gesicherte Kenntnisse der Stufe A1.
Einstufungstest mit Ergebnis A2.1.

Content:
In diesem Modul werden Grundkenntnisse in der Fremdsprache Spanisch vermittelt, die es den Studierenden ermöglichen, sich in alltäglichen Grundsituationen zurechtzufinden, z.B. Freizeitaktivitäten, auf Reisen, im Restaurant, unter Kommilitonen, Freunden und Nachbarn, Austausch von Erfahrungen etc. Dabei werden interkulturelle und landeskundliche Aspekte berücksichtigt.
Die grammatikalischen Strukturen werden weiter aufgebaut, wie z.B. die Verwendung von den Vergangenheiten pretérito perfecto - pretérito indefinido, ser und estar, unbetonte Personal Pronomen etc.
Es werden Strategien vermittelt, die mündlich wie schriftlich eine Verständigung trotz noch geringer Sprachkenntnisse ermöglichen.

Intended Learning Outcomes:
Dieses Modul orientiert sich am Niveau A2 „Elementare Sprachverwendung" der GER. Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage, die Bedeutung von kurzen, klaren und deutlich artikulierten Mitteilungen und Durchsagen zu erfassen. Die Kommunikation ist im Rahmen von einfachen, routinemäßigen Kontexten möglich. Der Austausch von Informationen erfolgt über kurze Dialoge mit verschiedenen Zeitbezügen (z.B. Gegenwart, Vergangenheit, einfaches Futur) und umfasst einfache Satzgefüge mit beschränkten Strukturen zu vertrauten Tätigkeiten. Der/Die Studierende kann einfache Fragen zu Inhalten stellen und auch beantworten. Gespräche und Dialoge sind kurz, zeitlich beschränkt und orientieren sich inhaltlich an Kontexten, wie z.B. Familie, Freunde, Lebens- und Wohnraum, Reisen. Die Studierenden können kurze Texte oder Briefe lesen und verstehen, wenn diese einen häufig gebrauchten Wortschatz und bekannte Strukturen beinhaltet und wenn darin vertraute Informationen zu finden sind. Er/Sie ist in der Lage mithilfe feststehender Wendungen kurze, einfache Mitteilungen oder persönliche Briefe zu verfassen.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese-, Schreib- und Sprechaufgaben in Einzel-, Partner und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Durch die Kombination dieser Aufgaben wird die Interaktion mit den Partnern unterstützt und gefordert. Die Studierenden erwerben Teamkompetenz durch kooperatives Handeln in gemischten Gruppen.
Es werden Möglichkeiten aufgezeigt, den Lernprozess in der Fremdsprache Spanisch eigenverantwortlich und effektiver zu gestalten und damit die eigenen Lernfähigkeiten zu verbessern.
Durch kontrolliertes Selbstlernen grundlegender grammatischer Phänomene und Kommunikationsmuster in der Fremdsprache mit vorgegebenen (online-) Materialien werden die im Seminar vermittelten Grundlagen vertieft.
Freiwillige Hausaufgaben (zur Vor-und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online.

Reading List:
Lehrbuch (wird in der Lehrveranstaltung bekanntgegeben).

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Spanisch A2.1 (Seminar, 2 SWS)
Galan Rodriguez F, Guerrero Madrid V, Hernandez Zarate M, Mayea von Rimscha A, Rey Pereira C, Tapia Perez T
For further information in this module, please click campus.tum.de or here.

Module Description

SZ1701: Norwegian A1 | Norwegisch A1

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** Language taught	**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:
Studien-/Prüfungsleistungen:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
keine

Content:
In diesem Modul werden Grundkenntnisse in der Fremdsprache Norwegisch vermittelt, die es den Studierenden ermöglichen, sich in alltäglichen Grundsituationen trotz geringer Sprachkenntnisse zurechtzufinden. Wir lernen / üben grundlegendes Vokabular zu Themen wie Familie, Wohnen, Beruf, Freizeit, Landeskunde und in einfach strukturierten Haupt- und Nebensätzen Alltägliches im Präsens zu berichten; Plural der Nomen; Personal-, Reflexiv-, Demonstrativ- und einige Possessivpronomen; einfache Negationsformen; den Gebrauch einiger Modalverben und Präpositionen; Adjektivdeklination.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A1 des GER. Der/die Studierende erlangt Grundkenntnisse in der Fremdsprache Norwegisch mit allgemeinsprachlicher Orientierung unter Berücksichtigung kultureller und landeskundlicher Aspekte. Nach Abschluss dieses Moduls kann er/sie alltägliche Ausdrücke und sehr einfache Sätze verstehen und verwenden, die auf die Befriedigung konkreter, in der Bewältigung des Alltags wesentlicher Bedürfnisse zielen. Der/die Studierende kann sich auf einfache Art verständigen, wenn die Gesprächspartner langsam und deutlich sprechen und bereit sind zu helfen.
Er/Sie kann beispielsweise einfache Fragen zu Person und Familie stellen und beantworten sowie Verabredungen treffen.

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; gezielte Hör-, Lese-, Schreib- und Sprechübungen; Einzel-Partner- und Gruppenarbeit; Kontrolliertes Revidieren einzelner Aspekte der Grammatik mit vorgegebenen (online-) Materialien; Referieren und Präsentieren nach vorgegebenen Kriterien; moderierte (Rollen-) Diskussionen.
Freiwillige Hausaufgaben zur Vor- und Nachbearbeitung festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial

Reading List:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial (wird in der LV bekannt gegeben)

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Norwegisch A1 (Seminar, 2 SWS)
Noch nicht bekannt N
For further information in this module, please click campus.tum.de or here.

Module Description

SZ1702: Norwegian A2 | Norwegisch A2

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** Language taught	**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:
Studien-/Prüfungsleistungen:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Bestandene Abschlussklausur A1

Content:
In diesem Modul werden Grundkenntnisse in der Fremdsprache Norwegisch vermittelt, die es den Studierenden – trotz geringer Sprachkenntnisse – ermöglichen sollen, sich in alltäglichen Grundsituationen zurechtzufinden.
Wir lernen/üben grundlegendes Vokabular und Konversationen und produzieren auch kürzere Texte (z.B. E-Mail, Textzusammenfassung und Kurzpräsentationen); vertiefen und erweitern die Grammatik aus der A1-Stufe und lesen Texte in leicht leserlicher Form.

Grammatische Inhalte: Wiederholung der Pronomen; Komplettierung der Possessivpronomen; komplexer strukturierte Haupt- und Nebensätze mit Modalverben; Imperativ; Präteritum; Perfekt und Plusquamperfekt; Zeitausdrücke-/angaben; Zeit-, Ort- und Richtungsadverbien; Steigerung des Adjektivs.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A2 des GER. Der/Die Studierende erlangt Grundkenntnisse in Norwegisch mit allgemein sprachlicher Orientierung unter Berücksichtigung kultureller und landeskundlicher Aspekte.
Nach Abschluss dieses Moduls kann der/die Studierende im Gespräch einfache Sätze und Redewendungen zu einem erweiterten Spektrum an vertrauten Themen verstehen und gebrauchen. Dabei handelt es sich um grundlegende Informationen zu alltäglichen Themen unter Einbeziehung landeskundlicher Aspekte. Der/die Studierende ist in der Lage kurze informative Texte oder Mitteilungen zu grundlegenden Situationen zu verfassen und kann längere Texte zu vertrauten Themen verstehen, in denen gängige bzw. einfache alltagsbezogene Sprache verwendet wird und in denen vorhersehbare Informationen zu finden sind.

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; gezielte Hör-, Lese-, Schreib- und Sprechübungen; Einzel-Partner- und Gruppenarbeit; Kontrolliertes Revidieren einzelner Aspekte der Grammatik mit vorgegebenen (online-) Materialien; Referieren und Präsentieren nach vorgegebenen Kriterien; moderierte (Rollen-) Diskussionen.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial

Reading List:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial (wird in der LV bekannt gegeben)

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Norwegisch A2 (Seminar, 2 SWS)
Noch nicht bekannt N
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:
Einführung Ökonomie NaWaRo - Überblick Märkte Nawaro (Vorlesung, 1,5 SWS)
Decker T

Einführung Ökonomie Nawaro - Ökonomie Nawaro - Übung (Übung, 1 SWS)
Kondrasch J, Röder H

Einführung Ökonomie NaWaRo - Ökonomie NaWaRo - Vorlesung (Vorlesung, 1,5 SWS)
Röder H [L], Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1146: Social Media Marketing | Social Media Marketing

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 30	**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 includes an oral presentation (30-45 minutes) to demonstrate the students' knowledge and ability to apply basic issues of marketing.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Social media marketing: social media strategies, social media monitoring, online reputation management, forums and und rating platforms, blogs, twitter, social networks, social sharing, mobile social marketing, social commerce, crowdsourcing

Intended Learning Outcomes:
Students gain basic knowledge of marketing. They understand how communication works and can apply certain aspects of the field of social media marketing.

Teaching and Learning Methods:
The module includes lectures and seminars, including work on case studies, videos and best practice examples.

Media:
Script, ppt, internet

Reading List:
Bibliography shall be compiled according to key aspects

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

WZ1167: Work Science and Work Safety | Arbeitswissenschaft und Arbeitssicherheit

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:
In a written examination (60 minutes), students should be able to retrieve their knowlege of work management and occupational safety. Various scenarios will be introduced to illustrate the relationship between risks and accidents. Under time contraints, students should be able to list and evaluate scientific methods to measure work load and difficulty as well as their various potential uses.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Basics of work science such as the physiological principles of human work, knowledge of working place and ergonomics, allocation of working hours, occupational planning and costs. Examples of measurement of work load and difficulty as well as the impact of work. Occupational safety in dangerous situations arising from human error. Occupational psychology, motivation and staff management, taking examples from the production of renewable resources.

Intended Learning Outcomes:
After completion of this module, students are aware of the basics of work management. They can analyze work processes in the sector renewable resources production and strategic planning for mechanisation. Students recognize the importance of occupational safety and understand particular workplace situations on the basis of occupational psychology. They recognize the importance of motivation and the factors influencing it and can apply various aspects of project management.

Teaching and Learning Methods:
Lectures to teach basic knowledge; presentations; exercises to apply scientific methods to measure work load and difficulty. Films to highlight the risks inherent to the production of renewable resources.

Media:
Script, PowerPoint presentation, internet research, Film presentations, work in groups

Reading List:
Arbeitswissenschaft Gebundene Ausgabe – Springer; Auflage: 2. vollst. neubearb. Aufl. (16. Dezember 1997)
von Holger Luczak (Autor), J. Springer (Assistent), T. Müller (Assistent), M. Göbel (Assistent) ;
Arbeitswissenschaft Gebundene Ausgabe – Springer; Auflage: 3., vollst. überarb. u. erw. Aufl. 2010
von Christopher M. Schlick (Autor), Ralph Bruder (Autor), Holger Luczak (Autor) ;
Schriften der schweizerischen SUVA

Responsible for Module:
Alexander Höldrich (Alexander.hoeldrich@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung und Übung
Arbeitswissenschaft und Arbeitssicherheit
2 SWS

Alexander Höldrich (alexander.hoeldrich@tum.de)
Simone Walker-Hertkorn (s.walker-hertkorn@wz-straubing.de)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1209: Applied Ethics to Regrowing Resources | Angewandte Ethik zu Nachwachsenden Rohstoffen

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:
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:
Alexander Höldrich (Alexander.hoeldrich@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Angewandte Ethik zu Nachwachsenden Rohstoffen (Vorlesung) (Vorlesung, 1 SWS)
Potzler A

Angewandte Ethik zu Nachwachsenden Rohstoffen (Übung) (Übung, 1 SWS)
Potzler A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1721: Renewable Resources in Medicine | Nachwachsende Rohstoffe in der Medizin

Version of module description: Gültig ab winterterm 2017/18

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 Assessment consists of a written examination (90 minutes)

Repeat Examination:

(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:
Cordt Prof. Dr. Zollfrank cordt.zollfrank@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung
Nachwachsende Rohstoffe in der Medizin
2 SWS
Dr. Albert Solleder, Prof. Dr. Cordt Zollfrank; Prof. Dr. Herbert Riepl

Seminar
Nachwachsende Rohstoffe in der Medizin
1 SWS
Dr. Albert Solleder, Prof. Dr. Cordt Zollfrank

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

Module Description

WZ9120: Psychology | Führungspsychologie

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:
For assessment, students answer questions and work on case studies applying the discussed problem-solving strategies.
It is to test whether students are able to understand the concepts and methods learnt and to reproduce them independently, where necessary, putting them into context and differentiating between their areas of application. Type of exam: In writing, Exam duration: 60 minutes

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Interest in leadership and willingness to reflect on oneself and on others

Content:
Communicating and working out fundamental leadership skills and abilities in view of the shift from the industrial age to the information and knowledge age. This primarily concerns communication, motivation, conflict management, target-setting and delegation. Topics also include how a modern manager can build and lead a team effectively and productively. Practical examples are worked on and practised with the help of various leadershipp sychology models and communication tools. The utility of a consistent, principle-based enterprise culture and its associated common language, including global aspects, is demonstrated and thereby rendered easily understandable.

Intended Learning Outcomes:
The seminar offers an overview of leadership skills and fields of competence. Seminar participants thereby gain an understanding of management tasks. They can recognise the demands of a manager's role-model function in the information and knowledge age. They are also aware of their competences and abilities they should individually improve and develop if they reach a management position. After the course, participants can apply management tools on a small scale

through exercises and role-playing with case examples. They can identify problem areas in this regard and deduce a corresponding need for action.

Teaching and Learning Methods:
Interactive teaching, talks, group work, discussions, practices, roll plays, short presentations

Media:
Flipchart, presentation, white board, work sheets

Reading List:
Kaunzner, C.: Herzschrittmacher für Teams
Covey, (Dr.) S.: 7 Wege zur Effektivität
Covey, S.: Schnelligkeit durch Vertrauen
Covey, S.: Führen unter neuen Bedingungen

Responsible for Module:
Christine Kaunzner (christinekaunzner@takechances.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Führungspsychologie (Vorlesung, 2 SWS)
Goerg S [L], Kaunzner C
For further information in this module, please click campus.tum.de or here.

Module Description

WZ9121: Rhetoric and Dialectic | Rhetorik und Dialektik

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:
The oral examination (20 minutes) evaluates a speech/talk regarding linguistic, stilistic and contentual aspects. Students individually work on a speech/talk and decide about their applied tools (e.g. overhead projector, beamer).

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
The basic forms of speech and response are analysed first. Thereafter, rhetorical and linguistic possibilities are studied specifically in the light of modern communicative systems.
Rhetoric – terminology and analysis. Vocabulary, syntax and logical structure form the next aspects of the lecture. Students are required to identify empty phrases and platitudes in their own way of expression and consciously avoid them in oral reports and presentations. Students are made aware of the rhetorical structure not only of speeches but also short statements, outlines and oral contributions to discussions. Students' own body language (facial expressions, gestures) and behavior are analyzed and adapted to their language and general verbal expression. The background of established behaviors is also explored. Not only the effect of one's own oral presentation on oneself, but also the impressions on others are discussed and criticized. Methods of argumentation are analyzed in dialectical terms. Speech and response are situated in the context of rhetorical possibilities.

Intended Learning Outcomes:
Students are able to demonstrate their skills in expression and content presentation applying the most appropriate rhetorical means. The German language is correctly used both from the

grammatical and stylistical point of view. In particular, general linguistic errors and empty phrases are largely avoided. Students can structure opinions, presentations and talks according to the presented principles. Communicative alternatives are identified. In discussions, dialogues and debates, verbal and non-verbal rules are implemented. In the end, students are able to prepare and give a full speech (oral presentation). Referring to important and historic speeches (Plato to Walter Jens), students should recognize the various rhetorical means and analyze them for their own work. The quality of the German and a holistic mode of expression in correct, well-formed sentences are an important criterion.

Teaching and Learning Methods:
Analysis of the term "rhetoric", various schools of rhetorics (Plato: Beauty of speech; Huxley: Efficiency of speech); internet research and secondary literature; turorial within the lecture

Media:
Manuscript, multimedia teaching and learning tools

Reading List:
Sekundary literature Kommunikation und Rhetorik wie Birkenbihl, (2010) Rhetorik: Redetraining für jeden Anlass Verlag: Ariston, Literatur der Klassik und Moderne. Tagesaktuelle Redebeiträge in Parlamenten.

Responsible for Module:
Joseph-Emich Rasch (j.e.rasch@das-pulverturm-theater.de)

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

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

Nawaro in Communication and Didactics | Nawaro in Kommunikation und Didaktik

Module Description

CS0258: Nawaro in Communication and Didactics | Nawaro in Kommunikation und Didaktik

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
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.

Master's Thesis | Master's Thesis

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:
60 Credits in compulsory and elective mdoules of the master study course Technology of biogenic resources

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.

Obligations | Auflagen

Requirement Proof of Proficiency in German | Nachweis Deutschkenntnisse

Module Description

SZ0337: German as a Foreign Language A1.1 | Deutsch als Fremdsprache A1.1

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 135	**Self-study Hours:** 90	**Contact Hours:** 45

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

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

Repeat Examination:

(Recommended) Prerequisites:
keine

Content:
In diesem Modul werden Grundkenntnisse in Deutsch als Fremdsprache unter Berücksichtigung interkultureller und landeskundlicher Aspekte vermittelt, die es den Studierenden ermöglichen, sich

trotz geringer Sprachkenntnisse z.B. beim Einkaufen, im Restaurant, im öffentlichen Verkehr etc. zurechtzufinden.
Sie lernen/üben grundlegendes Vokabular zu Themen wie Familie, Beruf, Freizeit und Essen, einfache Fragen zur Person/zur Familie zu stellen und zu beantworten, Zahlen, Preise und Uhrzeiten zu verstehen und zu benutzen und in einfach strukturierten Hauptsätzen Alltägliches im Präsens zu berichten, unter Verwendung von Verben, Nomen, Personalpronomen, Possessivartikel und Negationsformen.
Es werden Möglichkeiten aufgezeigt, den Lernprozess in der Fremdsprache eigenverantwortlich und effektiv zu gestalten. Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A1 des GER. Nach Abschluss dieses Moduls sind die Studierenden in der Lage alltägliche Ausdrücke und sehr einfache Sätze zu verwenden, die auf die Befriedigung konkreter Bedürfnisse des alltäglichen Bedarfs zielen: Sie können sich und andere vorstellen und anderen Leuten Fragen zu ihrer Person stellen und auf Fragen dieser Art Antwort geben, in einfacher Weise Tagesabläufe beschreiben und einfache schriftliche Mitteilungen zur Person machen. Sie können ihre Wünsche kommunizieren, wenn die Gesprächspartner deutlich und langsam sprechen und bereit sind zu helfen.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese, Schreib- und Sprechübungen erarbeitet werden. Durch die Kombination dieser Übungen in Einzel-, Partner- und wird der kommunikative und handlungsorientierte Ansatz umgesetzt. Durch kontrolliertes Selbstlernen grundlegender grammatischer Phänomene und Kommunikationsmuster in der Fremdsprache mit vorgegebenen (online-) Materialien werden die im Seminar vermittelten Grundlagen vertieft.
Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A1.1 (Seminar, 3 SWS)
Ammelung A, Burmasova S, Comparato G, Grgic T, Gröbl J, Huber D, Jennert J, Karsten-Ott M, Lechle K, Noch nicht bekannt N, Pinskaia I, Pletschacher T, Schlömer A, Schmidt-Bender S, Schneider S, Selent D, Steidten R, von Caprivi Caprara de Montecucculi A, Witzig B

Blockkurs Deutsch als Fremdsprache A1.1 (Seminar, 3 SWS)
Hanke C, Schlömer A, Selent D, Zerfass A
For further information in this module, please click campus.tum.de or here.

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