Module Catalog

M.Sc. Chemical Biotechnology

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 374

Compulsory Courses | Pflichtmodule

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

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

(e.g. optimization of precursor and cofactor availability) -
quantitative biology
- Strategies to engineer microbial systems for production of chemicals and fuels based on biogenic resources, side and waste streams.

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

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

Media:
PowerPoint, whiteboard

Reading List:

Responsible for Module:
Bastian Blombach

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

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

Module Description

CS0009: Enzymatic Biotransformations | Enzymatic Biotransformations [IBT]

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:

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

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

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

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

Reading List:

Responsible for Module:
Prof. Voker Sieber

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

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

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module "Bioprocess Engineering"

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

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

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

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

Media:
slides, interactive quizzes, scripts, practical exercises

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

Responsible for Module:
Prof. Dr.-Ing. Michael Zavrel Venessa Dsouza

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

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

Module Description

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

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

Version of module description: Gültig ab winterterm 2019/20

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

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

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

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

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

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

students-gerald-rau/10.4324/9780429425684

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

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

Responsible for Module:
Prof. Weuster-Botz Prof. Volker Sieber

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

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

Electives | Wahlmodule

Technical Electives | Fachspezifische Wahlmodule

Module Description

WZ1193: Biogas Technology | Biogastechnologie [BiGA]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	Language: English	Duration: one semester	Frequency: summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 100	**Contact Hours:** 50

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

Description of Examination Method:
Students take a written examination (90 minutes) to demonstrate their knowledge of microbial breakdown processes in the biogas process, as well as their ability to assess influencing factors. They also demonstrate their knowledge of various technologies for using biogas and can explain their respective advantages and disadvantages. Additionally, they demonstrate that they have understood the legal and economic framework conditions of biogas technology and are able to translate these to case examples. Students also show that they can develop basic concepts of biogas plants.They will answer questions on the topic in their own wording and explain case examples or work out calculations. Multiple-choice questions are also possible.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Required: basic knowledge in biology, especially microbiology, as well as general and organic chemistry, mathematics, physics and thermodynamics of cycles; of advantage: knowledge in agriculture and agricultural engineering

Content:
Microbiology of biogas processing, anaerobic substrate breakdown, factors influencing the fermentation process, process management strategies, biogas storage and purification; biogas recovery (e.g. use of a motor for power generation with or without the use of heat or feeding into the gas grid); legal-economic framework conditions; sustainability issues; competition for raw material and acceptance of biogas plants; aspects of biogas plant design.

Intended Learning Outcomes:
After successful completion of the module, students are able to develop concepts for biogas generation and recovery in a specific context. Students are aware of microbial breakdown processes in biogas plants and can differentiate between various influencing factors. They are also aware of various processes for the use of biogas and understand their advantages and disadvantages. Students recognize the meaning of biogas technology for sustainable energy supply. Students have a good knowledge of legal and economic framework conditions in the field of biogas generation and they are able to conceptualize basic biogas plants.

Teaching and Learning Methods:
Lectures given as presentations, with the help of a blackboard and interactive elements, in particular group work on case examples; optional: excursion to a biogas plant to deepen acquired knowledge in a real-life setting

Media:
PowerPoint presentation, slide notes, exercise sheets

Reading List:
D. Deublein, A. Steinhauser, Biogas from Waste and Renewable Resources - An Introduction, Wiley-VCH, 2010, ISBN-13: 978-3-527-32798-0, ISBN-10: 3-527-32798-3

Responsible for Module:
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

CS0003: Production of Renewable Fuels | Production of Renewable Fuels

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
End of Semester

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

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

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

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

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

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

Responsible for Module:
Prof. Jakob Burger

Courses (Type of course, Weekly hours per semester), Instructor:
Production of renewable fuels (Tutorial, Garching) (Übung, 2 SWS)
Burger J [L], Burger J, Rosen N, Staudt J, Wolf A

Production of renewable fuels (Tutorial, Straubing) (Übung, 2 SWS)
Burger J [L], Burger J, Rosen N, Staudt J, Wolf A

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

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

Module Description

CS0008: Enzyme Engineering | Enzyme Engineering [EE]

Version of module description: Gültig ab summerterm 2025

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

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

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

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

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

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

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

Media:
PowerPoint, lecture script, scientific publications

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

Responsible for Module:
Volker Sieber

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

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

Module Description

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

Version of module description: Gültig ab summerterm 2024

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

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

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

Repeat Examination:
End of Semester

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

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

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

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

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

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

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

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

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

Responsible for Module:
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

CS0017: Regulation of Microbial Metabolism | Regulation of Microbial Metabolism

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
End of Semester

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

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

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

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

Media:
PowerPoint, whiteboard

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

Responsible for Module:
Prof. Bastian Blombach

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

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

Module Description

CS0018: Plant Biotechnology | Plant Biotechnology [PlBioTech]

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

Media:
PowerPoint, whiteboard

Reading List:

Responsible for Module:
Prof. Dr. Erich Glawichnig

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

Module Description

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

Version of module description: Gültig ab winterterm 2022/23

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:

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

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

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

Media:
PowerPoint, script, task sheets

Reading List:

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

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

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

Module Description

CS0020: Glycomics | Glycomics

Version of module description: Gültig ab summerterm 2025

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

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

Description of Examination Method:
The module examination consists of a written exam (60 min). The students give definitions and draw or sketch the chemical structure. They answer comprehension questions about the methods covered in the lecture and explain the functional principles in words. Participation in the examination is subject to 90% attendance at the lecture and seminar.

Repeat Examination:
Next semester

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

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

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

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

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

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

Responsible for Module:
Broder Rühmann

Courses (Type of course, Weekly hours per semester), Instructor:
Glycomics (Lecture) (Vorlesung, 1 SWS)
Rühmann B [L], Rühmann B

Glycomics (Seminary) (Seminar, 2 SWS)
Rühmann B [L], Rühmann B
For further information in this module, please click campus.tum.de or here.

Module Description

CS0024: Electrobiotechnology | Electrobiotechnology [EBT]

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

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

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

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

Media:
Panel, slides, scripts, exercise sheets

Reading List:

Responsible for Module:
Prof. Nicolas Plumeré

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

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

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

Media:

Reading List:

Responsible for Module:
Dr. Corinna Urmann

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

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

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

Teaching and Learning Methods:
The course content is taught through a combination of lectures and exercises:

Lectures:
Theoretical principles are taught using presentations, graphics and sample calculations.
Case studies illustrate the practical applications of the concepts.

Interactive elements, such as short quizzes and discussions, encourage active participation.

Exercises:
Tasks on realistic problems help to understand the concepts.
Group work to promote interdisciplinary thinking and problem-solving skills.

Media:
Blackboard, slides

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

Responsible for Module:
Prof. Marc Ledendecker

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

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

Module Description

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:
Renewables Utilization (Exercise) (Übung, 2 SWS)
Schieder D

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

Module Description

CS0103: Bioinspired Materials and Processes | Bioinspired Materials and Processes [BioinspMaterProc]

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 individually study the literature and prepare topics from the area of bioinspired materials which they finally present to the class. Group work is optional. Assessment takes the form of an oral examination (30 minutes).Here, students should demonstrate their ability to categorize biological materials and processes. Students also show their ability to develop options for their application in technology and medicine as well as the production of bioinspired materials. No external tools are allowed in the examination.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Successful participation in the module "Basics of chemistry", "Biochemistry" and "Biopolymers" or comparable knowledge in chemistry, physics and materials science.

Content:
The fundamental principles of composition, structure and function of biological materials are introduced on the course. Topics covered include growth, the creation of biological forms and evolutionary strategies for optimization. Aspects of materials science in terms of self-organisation, stimulus dependence and adaptation are explained. The key properties and functions of biological materials are outlined, using selected examples This also includes biochemical processes in the formation of biological materials as well as strategies for the production of bioinspired materials. Current concepts and designs are developed using examples. Possible fields of application in technology and medicine are outlined in detail. The lecture comprises the following contents, among others:

Introduction: nature and technology, bionics, biomimetics, bioinspiration Fundamental aspects of biological materials: evolution, optimization, development, structures (lotus effect). hierarchy, biology vs. technology
Biominerals and hard tissue: cristallization, types of biomineralization, biominerals
Bioinspired materials: principles, strategies, production, zero-dimensional nanomaterials to complex structures, biotemplating
Fields of application: life sciences (materials for biomedine), technology (materials for energy and environment, materials for optics and technology

Intended Learning Outcomes:
After completion of the module, students are able to evaluate complex material systems in nature and work out differences between bionic and bioinspired materials. They feel able to select appropriate biomaterials and concepts for application to technical tasks and develop solutions including the synthesis of bioinspired materials meeting the demands. In addition, students can deduce production processes of new materials for medicine and technology.

Teaching and Learning Methods:
Lecture (talks given by teaching staff using PowerPoint and additional written material), seminar (students independently prepare a topic and present it in an oral presentation, peer instruction and constructive feedback

Media:
Presentations, lecture notes

Reading List:
D'Arcy W Thompson, On Growth and Form, Cambridge University Press (2000)
H Lowenstam, S Weiner, On Biomineralization, Oxford University Press (1989)
JF Vincent, Structural Biomaterials, Princeton University Press (1990)
P Gomez-Romero, C Sanchez Functional Hybrid Materials, Wiley-VCH (2004)
B Ratner, Biomaterials Science, Academic Press, London (2004)

Responsible for Module:
Cordt Zollfrank

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

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

Module Description

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 (Seminar) (Seminar, 1 SWS)
Zollfrank C [L], Helberg J

Biogenic Polymers (Lecture) (Vorlesung, 2 SWS)
Zollfrank C [L], Zollfrank C
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab summerterm 2025

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 is done as a written examination (duration 90 minutes). The main part of the exam is to solve typical problems by applying the methods aquired in the course. This typically involves writing small Matlab programs on paper. All course materials (slides, programs) can be brought as printouts and used as templates for this. Additionally, questions have to be answered to check the understanding of basic methods and principles as learned during the course.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Bachelor modules Mathematics & Physics; Module Basics of Numerical Methods, programming experience (ideally with Matlab)

Content:
Modelling and Simulation:
- physical models
- data-based models (look-up tables, polynomials, neural networks)
- methods for generating models

Optimization methods:
- linear optimization (linear regression)
- nonlinear optimization

Basics of process modelling & control theory
The methods treated in this course are complemented with practical examples that are chosen to show both the wide scope of application (engineering, natural sciences) and their relation to sustainability.

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 with embedded excercise. Lectures include presentations whose content is deepened by solving excercise problems autonomously in course. In order to improve the learning outcome, participants work at homework excercise problems. The solution is discussed in the following lecture.

Media:
PP presentation, blackboard, demonstration of programs

Reading List:
S. R. Otto & J.P. Denier, An Introduction to Programming and Numerical Methods in MATLAB, Springer, London, 2005
O. Nelles, Nonlinear System Identification, Springer, Berlin, 2010

Responsible for Module:
Prof. Josef Kainz

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

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

Module Description

CS0108: Catalysis | Catalysis

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
Results will be assessed by a written exam (90min), whereby the students explain important facts of technical catalysis chemistry, mechanistic aspects of catalysts how catalysts work, what is their typical composition and show practical applications by using examples.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic organic and inorganic chemistry

Content:
transition metal compounds, homogenous/heterogenous catalysis, mechanistic details of activation of organic and inorganic molecules at transition metal compounds, surface chemistry, characterisation of catalysts, heat/mass transfer at catalyst grains, reactor designs

Intended Learning Outcomes:
Students can show important chemical aspects of the phenomenon of catalysis with simple examples. They can show the implication of a catalyst in an overall reaction and can quantify it mathematically by using typical measurable values.

Teaching and Learning Methods:
Using lectures, basic principles of catalysts and catalysis will be transmitted.

Media:
Power point presentation, table, oral teaching, discussion

Reading List:
Dirk Steinborn, Grundlagen der metallorganischen Komplexkatalyse, Vieweg und Teubner Verlag, 2. Auflage 2009 (434 Seiten, 41 €).

Responsible for Module:
Prof. Herbert Riepl

Courses (Type of course, Weekly hours per semester), Instructor:
Catalysis (Lecture) (Vorlesung, 3 SWS)
Riepl H [L], Riepl H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0109: Sustainable Energy Materials | Sustainable Energy Materials [SEM]

From the basics to the application

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The learning outcomes will be checked through a written exam (90 minutes) in which the students have to reproduce essential aspects of sustainable energy materials and their applications through examples. In addition, mathematical problems will be given to show that the students are able to quantify simple examples.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of basic electrochemistry/physical chemistry is beneficial, but not required.

Content:
Sustainable energy management is an important issue to minimize environmental impact and climate change. Electrochemical devices such as fuel cells and batteries can help use Renewable In this course, you will learn about the basics of electrochemistry and various important devices used in current and future energy systems, such as fuel cells, batteries, and electrochemical water splitting. The lectures will cover the working principles, components, materials, applications, and future potential of these devices in the energy economy.
Using catalysts in chemical reactions can increase their speed and selectivity, leading to significant energy savings. One section of the course will focus on fuel cell catalysis, and other ideas such as using catalysts in chlorine electrolysis will be introduced to demonstrate how choosing the right counter reaction can result in energy efficiency. The topic of water splitting to obtain hydrogen will be covered later in the course.
We will examine the use of different materials in energy-related devices and how their electronic and ionic properties affect their performance.

Batteries play a crucial role in electromobility by efficiently storing and releasing electrical energy. One part of the course will cover Li-ion batteries, starting with an overview of their fundamentals and the most common cell types. In addition to discussing the characteristics of typical Li-ion electrode materials and electrolytes, the course will show how key performance characteristics such as energy density, power density, and lifespan are influenced by the cell chemistry. The course will also introduce concepts for the next generation of batteries, such as all-solid-state batteries.

Intended Learning Outcomes:
Upon successful completion of this course, students will be able to:
1. Understand and Explain Key Concepts in Electrochemistry:
o Remember and describe the fundamental principles of electrochemistry, including thermodynamics, kinetics, Pourbaix diagrams, and the Butler-Volmer equation.
o Explain the significance of electrochemical processes in energy conversion and storage technologies.
2. Analyze Electrochemical Systems:
o Interpret Pourbaix diagrams to determine the stability of materials in various pH and potential conditions.
o Apply the Butler-Volmer equation to analyze the kinetics of electrochemical reactions in different energy systems.
o Evaluate the thermodynamic feasibility of electrochemical reactions in sustainable energy applications.
3. Comprehend and Apply Battery Fundamentals:
o Understand the working principles of batteries, including charge/discharge processes, energy density, and power density.
o Differentiate between various battery types (e.g., lithium-ion, sodium-ion, solid-state, flow batteries) based on their materials, design, and application potential.
o Apply knowledge of battery chemistry to assess the performance and suitability of different battery types for specific sustainable energy applications.
4. Develop and Evaluate Sustainable Battery Solutions:
o Develop strategies for improving the efficiency, lifespan, and environmental impact of existing battery technologies.
o Critically evaluate the potential of emerging battery materials and technologies for future energy storage solutions.
5. Understand and Analyze Hydrogen Fuel Cells:
o Explain the principles of hydrogen fuel cells, including the role of catalysts, membrane technology, and the overall electrochemical process.
o Analyze the efficiency and challenges associated with hydrogen fuel cells in comparison to other energy conversion technologies.
o Evaluate the environmental and economic implications of hydrogen fuel cell deployment in various sectors.
6. Comprehend and Apply Knowledge of Electrolyzers:
o Understand the operation of electrolyzers, particularly in the context of hydrogen production from renewable energy sources.

7. Integrate Knowledge to Develop Sustainable Energy Solutions:
o Synthesize knowledge from electrochemistry, battery technology, and hydrogen energy systems to propose innovative solutions for sustainable energy storage and conversion.
o Critically evaluate the trade-offs between different energy materials and technologies, considering factors such as cost, scalability, environmental impact, and performance.
These learning outcomes are designed to ensure that students not only grasp the theoretical concepts of sustainable energy materials but also apply and evaluate these concepts in practical, real-world contexts.

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

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

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

Media:
1) Presentation Slides:
• Purpose: Presentation slides will be the primary medium for delivering content during lectures. They will be designed to visually complement the spoken content, providing clear and concise explanations of key concepts, diagrams, equations, and real-world examples.
• Usage: Slides will be used to illustrate complex ideas in electrochemistry, battery technology, and hydrogen systems, helping students to follow along and understand the material more effectively. Key points, equations (e.g., Butler-Volmer equation), and visual aids (e.g., Pourbaix diagrams) will be highlighted to enhance comprehension.
• Accessibility: All slides will be made available to students before or after the lectures via the course’s online platform, allowing for review and study at their own pace.
2) Online Learning Platform:

• Purpose: The online learning platform (e.g., Moodle, Blackboard) will serve as the central hub for course materials, communications, and assessments. It will facilitate a blended learning approach, integrating various media forms into a cohesive learning experience.
• Usage: The platform will host lecture slides, videos, reading materials, quizzes, and assignments. It will also be used for discussion forums where students can ask questions and engage in peer learning. This platform supports continuous access to resources and enables students to manage their learning effectively.
• Interactivity: Features such as quizzes, polls, and discussion boards will allow students to interact with the material and with each other, enhancing engagement and reinforcing learning.
3) Textbooks and Research Articles:
• Purpose: Textbooks and scholarly articles provide in-depth coverage of theoretical concepts and the latest research developments in the field. These resources are essential for supporting lecture content and offering additional perspectives on topics covered in the course.
• Usage: Core textbooks will be recommended for fundamental concepts, such as basic electrochemistry and battery technology. Research articles will be assigned to provide insights into recent advancements and emerging trends in sustainable energy materials. These readings will complement lecture content and form the basis for exercises and discussions.
• Depth: By engaging with these texts, students will deepen their understanding of the material and develop critical thinking skills, particularly in evaluating new research and technological developments.

Reading List:
Handbook of fuel cells, Wolf Vielstich, Hubert A. Gasteiger, Arnold Lamm, 2010
Electrochemical Systems, Karen Thomas-Alyea, John E. Newman, 2021

Responsible for Module:
Prof. Marc Ledendecker

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

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

Module Description

CS0134: Conceptual Process Design | Conceptual Process Design

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
The exam performance is effected by an oral exam. It is reviewed whether the students know the fundamentals of conceptual design of chemical and biotechnological processes and if they can apply this knowledge on the design and evaluation of complex processes. The exam consists of two parts: (a) 30 minutes preparation through solving a given problem set (b) 30 minutes of oral examination. In the beginning of part (b) the results of part (a) are presented by the student. (total duration 60 min)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowleadge of thermodynamics and apparatusses used for fluid sparations processes. It is recommended to visit at least the course "Introduction of Process Engineering" first.

Content:
Basics of cenceptual design of processes; Basics of computational process design including calculation of process parameters; transfer of fundamental scale-up criteria towards real problem solving; Balancing of all process streams; Deepened knowledge of engineering principles.

Intended Learning Outcomes:
The students are qualified to understand the fundamentals of design, calculations, and balancing of chemical processes and fluid separation courses after the course. They will aquire knowledge of different challenges of process design and how to master them.

Teaching and Learning Methods:
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. In the exercises performed as part of the module learned theory

shall directly be applied with a practical orientation by means of calculations and examples from targeted aspects of process design and calculation. based on a direct comparison of a chemical process with it´s biotechnical alternative they learn to apply their knowledge on reality based challenges. Additionally they will be qualified by an in-depth knowledge of the design of operation units including calculation of process parameters based on utilization of selected software tools.

Media:
Panel, slides, scripts, practical exercises

Reading List:
Moulijn et al. (2013). Chemical Process Technology. – John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom.
Biegler et al. (1997). Systematic Methods of Chemical Process Design. – Prentice Hall.
Doherty, M.F., Malone, M.F. (2001). Conceptual design of distillation systems. – Boston: McGraw-Hill.
Gmehling, J., Kolbe, B., Kleiber, M., Rarey, J. (2012). Chemical Thermodynamics for Process Simulation. 1. Auflage. Weinheim: Wiley – VCH
Grassmann, P., Widmer, F., Sinn, H. (1997). Einführung in die Thermische Verfahrenstechnik. 3. vollst. überarb. Auflage. Berlin: de Gruyter.
Stichlmair, J.G., Fair, J.R. (1998). Distillation: Principles and Practice. – New York: Wiley – VCH.

Responsible for Module:
Jakob Burger burger@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Conceptual Process Design (Exercise) / Conceptual Design of Fluid Separations (Übung, 2 SWS)
Burger J, Fröschl D, Ibanez M, Rosen N

Conceptual Process Design (Lecture) / Conceptual Design of Fluid Separations (Vorlesung, 2 SWS)
Burger J [L], Burger J, Fröschl D, Ibanez M, Staudt J
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], Huber B, Meilinger S, Putra L, Schenker M, Veiltl P
For further information in this module, please click campus.tum.de or here.

Module Description

CS0140: Advances in Bioprocess Engineering | Advances in Bioprocess Engineering [ABE]

Advances in Bioprocess Engineering

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The learning outcomes are evaluated by a graded seminar presentation. The prsentation allows the students to assess the extent to which they can summarize a complex scientific work in the field of Bioprocess Engineering correctly and present it to an audience in a comprehensible and convincing way.

Repeat Examination:

(Recommended) Prerequisites:
Modules: Bioprocess Engineering, Downstream Processing, Conceptual Design of Bioprocesses

Content:
The technical content of the course focuses on current research results in the field of Bioprocess Engineering (Fermentation, Downstream Processing, Scale-up). This seminar focuses on particularly sustainable bioprocesses that, for example, use agricultural residues, are less harmful to the environment or protect the climate.

Intended Learning Outcomes:
The students know the current and relevant methods and applications of Bioprocess Engineering and are able to evaluate and classify them. Students can acquire, present and critically discuss relevant technical literature.

Teaching and Learning Methods:
First, a selection of current publications is made and a preliminary discussion of the respective topics with the students takes place. The students then work out a presentation which they then present and discuss in the seminar.

Media:
presentations, publications

Reading List:
will be given out at the start

Responsible for Module:
Michael Zavrel

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

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

Module Description

CS0149: Renewable Resources in Medicine | Renewable Resources in Medicine

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The Assessment consists of a written examination (90 minutes)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Requirements for the successful participation is basic knowledge in chemistry, cell and microbiology, biochemistry, materials science and renewable ressources

Content:
The course provides basic knowledge on the human anatomy, cell biology on general and the cell membranes in particular. The interaction of materials with cell surfaces and tissue will be introduced. The general issues related to pharmacology and the fabrication of drugs from from renewable ressources will be discussed. The application of renwable resources as the main course topic in surgery, internal medicine, plastic and reconstructive surgery as well as wound dressings will introduced. Future tasks for the medical application of renewable resources are outlined. The legislative framework for application of medical products and fabrication will be discussed.

Intended Learning Outcomes:
The successful visit of this course enables the students to select materials from renewable ressources for relevant fields in medicine (skin, muscle, bone) and can particularly assess the valueof their applicability. They are able to apply the most important legislation in medical application and to validate the material reqeuiements for the application in humans (biocompatibility). They are able to identify and develop new concepts for sustainable materials

from renwable ressources in medicine due to their aquired medical, chemical and materials science knowledge and they can set the base for the potiental application of such materials.

Teaching and Learning Methods:
Lecture (talk by teaching staff) with media, seminar on case studies

Media:
Presentation, script, examples, case studies

Reading List:
The following literature is recommended: Buddy Ratner et al.: Biomaterials Science - An Introduction to Materials in Medicine, Elsevier

Responsible for Module:
Prof. Cordt Zollfrank

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

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

Module Description

CS0156: Material Application for Renewable Resources | Material Application for Renewable Resources

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
During the seminar, students independently work on a selected topic from the field of biobased materials and give an oral presentation with PowerPoint-handout (min. 10 slides). Group work is compulsory (3 – 5 persons). The students will implement their own online survey and present the findings in the context of the relevant literature in the presentation (each student has to present 5 minutes). The oral presentation shall be assessed according to content of the PowerPoint-handout and rhetoric aspects. The PowerPoint-handout summarizes the relevant literature, data, and key findings. Weighting: PowerPoint-handout 1, oral presentation 1.
The seminar work is not part of the written exam. However, midterm bonus points can be achieved which will have an effect on the individual final grade (-0,3).

Assessment requires a written examination (90 minutes). Students demonstrate their knowledge of physico-chemical properties and possible applications of biobased materials, as well as their environmental impact. Students are able to develop options for chemical synthesis and production processes of biobased plastics. No further tools are allowed in the examination.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in "Basics in chemistry " and “Biogenic Polymers”, as well as knowledge of materials and chemical compounds, or comparable knowledge of chemistry and physics.

Content:
Lectures give an overview the applications for biogenic resources in materials industry. Starting with the chemical composition and physic-chemical properties of the raw materials, the module introduces students to production and processing of biodegradable and non-biodegradable

bioplastics, as well as of natural fibre composites. It also covers material properties, relevant fields of application, their environmental impact, as well as current market trends.
In the seminar, students independently work on research papers and based on that, give a presentation to fellow students.

Intended Learning Outcomes:
After successful participation, students are able to assess opportunities and barriers for the application of biobased plastics, as well as their environmental impact compared to conventional plastics. Above all, they are competent to select suitable feedstocks, classes and types of materials, as well as processes to meet the technical requirements of a specific target product, having lower environmental impact at the same time.

Teaching and Learning Methods:
Lecture (talks using PowerPoint slide media, books and additional written material), seminar (independent work on a selected topic with subsequent presentation, peer instruction and constructive feedback).

Media:
Presentations, slide notes

Reading List:
Endres, H.J., Seibert-Raths, A., Technische Biopolymere, Carl Hanser Verlag, München, 2009
Pickering, K. L. (Hrsg.): Properties and performance of natural-fibre composites, CRC Press, Boca Raton 2008
Lewin, M.(Hrsg.): Handbook of Fibre Chemistry, Marcel Dekker, New York, 1998

Responsible for Module:
Bettina Fink (bettina.fink@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

CS0179: Advances in Metabolic Engineering | Advances in Metabolic Engineering [AMB]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The learning outcomes are tested by a graded seminar presentation. The presentation allows the students to assess the extent to which they can summarize a complex scientific work in the field of Metabolic Engineering correctly and present it to an audience in a comprehensible and convincing way.

Repeat Examination:
Next semester

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

Content:
The technical content of the course focuses on current research results in the field of Metabolic Engineering. Molecular biological-methodical as well as biotechnological application-oriented work is dealt with, for example:
- Genome meditation using CRISPR / multiplex gene silencing approaches using CRISPRi or sRNA binding protein Hfq
- Multiplex genome editing through natural transformation (MuGENT)
- Biological sensor/reporter systems and switches
- Chassis organisms and minimal genomes by means of genome reduction and genome assembly of synthetic DNA fragments (top-down and bottom-up approaches)
- Implementation of novel capabilities and functions in established biotechnologically used organisms (e.g. C1-fixation, N-fixation...)
- Recombineering

- Strategies for sustainable production based on waist- or side streams

Intended Learning Outcomes:
The students know the current and relevant methods and applications of Metabolic Engineering and are able to evaluate and classify them. Students can acquire, present and critically discuss relevant technical literature.

Teaching and Learning Methods:
First, a selection of current publications is made and a preliminary discussion of the respective topics with the students takes place. The students then work out a presentation which they then present and discuss in the seminar.

Media:
Powerpoint, blackboard work

Reading List:

Responsible for Module:
Prof. Dr. Bastian Blombach

Courses (Type of course, Weekly hours per semester), Instructor:
Advances in Metabolic Engineering (Seminar, 2 SWS)
Hädrich M, Vital S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0181: Advanced Electrochemistry | Advanced Electrochemistry

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The learning results are proved in form of a written test (60 min exam duration) at the end of the semester. During the semester four online test to each of the main topics of this module are offered as voluntary mid-terms. The online tests are opened in the week after a main topic was concluded and remain open for five days. Up to 10% of the total number of points of the final examination can be credited as bonus points. The results of the online tests, which are held during the semester, determine the amount of bonus points. At least 65% of the points in the online test must be achieved in order to receive bonus points. This means the online test are not graded, the points reached in the online test only determine if and how many bonus points a student gets for their final examination. It is not possible to raise the grade from 4.3 or worse to 4.0. This should encourage students to continuously participate in the lectures and exercises which are very important to them. Based on questions to electrochemical aspects the students prove that they know the corresponding technical terms, designations and contents, that they understand the basic relations and are able to apply their knowledge concerning the reactions taking place within the scope of kinetic and thermodynamic connections. For that purpose, concrete computational tasks are assigned.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Participation in the Modules “Allgemeine Chemie” and “Physikalische Chemie”, “Mathematik” und “Physik” or similar courses. In general the student should have a basic knowledge of the reaction kinetics and thermodynamics.

Content:
- Fundamentals of Electrochemistry: Thermodynamics (electrochemical potential, electrode potential, Nernst equation), transport in solution (migration, diffusion, convection), thermodynamics of interface (the electrical double layer), electrochemical kinetics.
- Stationary Electrode Voltammetry (Potential pulse, linear sweep and cyclic voltammetry at macro- and microelectrodes) for determination of thermodynamic and kinetic parameters.
- Mass transport by convection (Rotating disc electrode and rotating ring/disk electrode), thin film methodology, ultra-micro electrodes, flow-cell electrodes.
- Electrochemical Impedance Spectroscopy (general principles, data acquisition and modelling, data analysis and interpretation).
- Implementations of electrochemistry (Renewable energy conversion, green electrosynthesis, Sustainable energy harvesting and storage)

Intended Learning Outcomes:
The students acquire knowledge of advanced concepts of electrochemistry. They master the most important analytical techniques for investigating and evaluating electrochemical systems and know how to control them. In particular, they understand where and when certain measurement techniques are used and what knowledge they gain from them. Based on this, they are able to investigate the same system under different limiting conditions. Furthermore, the students are familiar with the electrochemical processes relevant in industry, such as the conversion of renewable energies, green electrosynthesis and sustainable energy generation and storage, and can apply their theoretical knowledge to these processes. Furthermore, they know concrete application examples from research and industry and how these can be designed and optimised.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using text documents, PowerPoint presentations and blackboard sketches. This enables a way of delivering the teaching content to the students in detail and answering questions as soon as they arise. PowerPoint slides and blackboard sketches create a visual assistance to understand the complex relationships in electrochemistry. Additionally, the students are provided with exercises to consolidate what they have learned in the lecture. The solutions to those exercises are later presented and discussed by the students in a practice lesson.

Media:
Presentations, Moodle course with online tests, exercise sheets, question cataloge, PowerPoint, script

Reading List:
Elektrochemie, Hamann/Vielstich, ISBN: 3527310681
Electrochemical Methods: Fundamentals and Applications; Bard/Faulkner, ISBN-13: 978-0471043720

Responsible for Module:
Prof. Nicolas Plumeré

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Electrochemistry (Vorlesung, 2 SWS)
Plumeré N [L], Plumeré N

Advanced Electrochemistry (Übung, 1 SWS)
Plumeré N [L], Seveur P
For further information in this module, please click campus.tum.de or here.

Module Description

CS0219: Protein-based Materials for Technology | Protein-based Materials for Technology

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The performance test will be in the form of a written examination. The students should demonstrate an understanding of the lecture content and its applications to problems related to proteins-based materials in the exam. No auxiliary means are allowed in the exam. 120 min examination time.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
This course will intend to consolidate concepts in Physics, Mechanics, Physical Chemistry, Biology, Engineering, and Chemistry having the focus on articles describing protein-based materials and their used in technological platforms. As such, knowledge in Physics, Chemistry, Mechanics, and Biology is required.

Content:
The module aims to provide in-depth knowledge to the students in physical chemistry, spectroscopy, thermodynamic, protein structure, and optoelectronics applied to protein-based materials. The module will study scientific articles that describe protein-based materials. The first focus will be on extracting information about the structure-functionally relationship of proteins and their interaction with other molecules and macromolecules and the different techniques used for that purpose. The second focus will be on studying how protein-based materials can have applications outside the typical biology range.
The course will study at least one scientific article per session to cover protein-based materials with applications in optoelectronics, medicine, and chemistry.
Each topic will be addressed, refreshing the most important physicochemical principles and more useful techniques followed by their relevance in these materials' structural and functional aspects and their application.

Intended Learning Outcomes:
At the end of the module, the students will be able i) to critically evaluate the information in scientific articles relating to novel protein-based materials for technology; ii) to analyze protein-based materials using a physicochemical perspective; iii) to describe the different ways protein interact with other molecules or macromolecules to form functional materials; iv) to describe the main role and characteristics of protein-based materials in technological platforms. They will be able to examine the structure of proteins and other molecules and macromolecules and the forces that define their functionality. They will be able to apply these concepts in bio-based and bio-inspired technologies.

Teaching and Learning Methods:
This course attendance includes lectures and seminars. For this purpose, powerpoint presentations, practical training materials, and open discussion seminars will be used.

Media:
The following forms of media apply: script, powerpoint, films, and blackboard

Reading List:
1. Physical Chemistry for the Biological Sciences, 2nd Edition Gordon G. Hammes, Sharon Hammes-Schiffer, Wiley, 2015, ISBN: 978-1-118-85900-1
2. Physical Chemistry for the Life Sciences, 2ndEdition Peter Atkins and Julio De Paula Oxford University Press ISBN: 978-0-19-956428-6
3. Introduction to Biophotonics Paras N. Prasad Wiley 2003, ISBN: 0-471-28770-9.
4. Introduction to Biomechanics Duane Knudson Springer 2007 ISBN: 978-0-387-49311-4

Responsible for Module:
Prof. Dr. Rubén D. Costa Dr. Juan Pablo Fuenzalida Werner

Courses (Type of course, Weekly hours per semester), Instructor:
Protein-based materials for technology (Vorlesung, 2 SWS)
Costa Riquelme R [L], Costa Riquelme R, Atoini Y, Banda Vazquez J

Protein-based materials for technology (Exercise) (Übung, 2 SWS)
Costa Riquelme R [L], Costa Riquelme R, Atoini Y, Banda Vazquez J
For further information in this module, please click campus.tum.de or here.

Module Description

CS0225: Flow Biocatalysis | Flow Biocatalysis [FCB]

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 75	**Contact Hours:** 45

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

Description of Examination Method:
The learning results are proved in form of a presentation and a discussion (30 min per participant, 50 % of grade).A written report to the experiments has to be also submitted). Based on current developments in flow chemistry and enzymatic biotransformation the students must prove their knowledge to the corresponding state of the art and technical terms, their skill to design and conduct enzymatic cascades in flow, and their ability to evaluate obtained results and identify bottlenecks. Students must prove that they have understand the basics of flow biocatalysis and its applications in academia and industry.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Students must have been successfully completed the course “enzymatic biotranformation, CS 0009” in order to be enrolled to this course.

Content:
Principles of flow chemistry (flow reactor design, fluid dynamics, residential time)
Enzyme immobilization techniques (absorption, covalent, ligand interaction)
Introduction to PAT (process analytical technology) in flow biocatalysis
Examples of enzymatic cascades in flow (recent scientific reports and articles)
Principles of flow biocatalysis with whole cells (biofilms)
Flow biocatalysis in industry.

Intended Learning Outcomes:
After visiting the module, students know fundamentals of flow biocatalysis and first-hand experience in enzymatic purification and immobilization. They have deepend their previous knowledge of enzymatic biotransformation by performing a multi-enzymatic cascade in flow to

produce fine chemicals. They understand the interaction between the different parameters of multi-enzymatic cascades; they can determine the bottlenecks of such cascades and find solutions to overcome them. Furthermore, the students gained a border perspective about the different techniques for enzyme purification and immobilization, product extraction and quantification, and calculations of reaction efficiency. Finally, the students learned how to transfer their knowledge towards industrial processes and address the environmental and economic challenges related to them.

Teaching and Learning Methods:
The content of the module is taught theoretically in the seminar (1 SWS). The experimental part of the module will be taught in form of a practical course (2 SWS). In the lecture the content will be conveyed by speech of the lecturer using PowerPoint presentations and Whiteboard sketches. This enables a way of delivering the teaching content to the students in details and answering the arose questions straight-ahead. PowerPoint slides and sketches create a visual assistance to understand the content. Additionally, the students will be provided with the recent published literature on flow biocatalysis to bring their knowledge to edge of the current science. A Part of the literature content will be introduced into the Power point slides to assist students in understanding scientific articles. In the practical course, students will learn how to design and construct a flow reactor for enzymatic cascades. They will learn how to purify enzymes and immobilize those using different techniques. Finally, students will integrate the immobilized enzymes into the flow reactor to perform a multi-enzymatic cascade and will evaluate the final product using analytical methods.

Media:
Presentations, PowerPoint, script

Reading List:
Recent published scientific articles and reviews. It will be provided prior to the course.

Responsible for Module:
Ammar Al-Shameri (a.al-shameri@tum.de)

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

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

Module Description

CS0235: Methods and Applications of Synthetic Biology | Methods and Applications of Synthetic Biology

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Achievement of the desired learning objectives will be verified in a written final exam (90 minutes). In the exam, the students demonstrate that they understand and can explain the methods and applications covered in the module. Students will also demonstrate that they are able to predict the functions of engineered biological systems and that they can analyse results presented in figures from scientific publications.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamental knowledge in molecular biology

Content:
- DNA synthesis and assembly
- Design of dynamic regulatory circuits
- CRISPR/Cas tools and applications
- Cell-free synthetic biology
- Bottom-up assembly of life-like systems
- Biosensor design
- Optogenetics
- High-throughput screening
- Microfluidics
- Applications of synthetic biology tools in sustainable biomanufacturing, health and environment

Intended Learning Outcomes:
After successful participation in the module, students understand important synthetic biology methods such DNA assembly, cell-free prototyping, CRISPR/Cas tools, optogenetics, automation and high-throughput screens. Students will be able to explain applications of synthetic biology in sustainable biomanufacturing, health and environment. They are also able to discuss risks and benefits of these applications and their impacts on the environment and society.
Furthermore, after completing the module, students can analyze the results of synthetic biology experiments in recent scientific publications, and hypothesize on the outcomes of further experiments.

Teaching and Learning Methods:
The contents of the lectures are conveyed by a talk of the lecturer based on slide-supported presentations. The content of the lecture with be supplemented by self-study of recent scientific publications that are provided to the students. The lecture will be supplemented with quizzes and discussions among students to promote critical reflection and active engagement with the contents.

Media:
Slides, scientific publications (provided), online quizzes

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

Responsible for Module:
Henrike Niederholtmeyer

Courses (Type of course, Weekly hours per semester), Instructor:
Methods and Applications of Synthetic Biology (Vorlesung, 2 SWS)
Niederholtmeyer H [L], Niederholtmeyer H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0236: Recent Topics in Cell-free and Bottom up Synthetic Biology | Recent Topics in Cell-free and Bottom up Synthetic Biology

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The learning outcomes will be tested by a graded seminar presentation and by active participation in the discussions. In the presentation, the students demonstrate that they are able to understand a scientific publication by extracting its key messages and by presenting its findings and methods in a comprehensible way. In their presentation, they also demonstrate that they can critically evaluate a study.

Repeat Examination:

(Recommended) Prerequisites:
Fundamental knowledge in molecular biology

Content:
The course focuses on recent research in the fields of cell-free and bottom up synthetic biology.
- Cell-free transcription and translation
- Cell-free prototyping to characterize new parts and networks for basic science and applications in sustainable production and health
- Cell-free biomanufacturing
- Cell-free biosensing
- Construction of life-like systems from the bottom up
- Self-replication of biochemical systems
- Synthetic compartments
- Microfluidic methods in cell-free and bottom up synthetic biology

Intended Learning Outcomes:
After successful participation in the module, students are able to explain current methods in cell-free and bottom up synthetic biology. They understand the goals of research in the field and can discuss recent examples from the scientific literature. Furthermore, students will be able to extract key messages from scientific publications and to present them in an engaging manner to their peers. They will be able to logically structure a presentation about a scientific publication, and to judge if its conclusions are supported by the data.

Teaching and Learning Methods:
Students select a recent publication from the field of cell-free and bottom up synthetic biology from a list of topics that is provided. The course begins with a slide-supported presentation by the lecturer to give an overview over the field and to provide instructions to the students. The students prepare a presentation about the selected publication and its methods. Individual meetings will be scheduled to support the students in their preparations. Student presentations take place in the seminar and the presented results will be discussed.

Media:
Slides, scientific publications (provided)

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

Responsible for Module:
Henrike Niederholtmeyer

Courses (Type of course, Weekly hours per semester), Instructor:
Recent topics in cell-free and bottom up synthetic biology (Seminar, 2 SWS)
Niederholtmeyer H [L], Banlaki I, Crean E, Gaizauskaite A, Kalkowski J, Li Y, Niederholtmeyer H, Osmanova G, Sharma B
For further information in this module, please click campus.tum.de or here.

Module Description

CS0237: Project Week: Practical Enzyme Engineering | Project Week: Practical Enzyme Engineering [P-EnzEng]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** irregularly
Credits:* 5	**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 results produced in the practical section will be presented in a written report of a maximum of 15 pages. The students will present the topic with a brief introduction, results section and discussion of the results as well as a brief outlook giving a suggestion of further experiments. The student will prove that they have understood the used methods and the rationale of the experiments and can apply this knowledge to plan further studies.

Repeat Examination:

(Recommended) Prerequisites:
Successful participation in the course “Enzyme engineering” (CS0008 or CS0076)

Content:
The module introduces the students to a real-life scientific project of enzyme engineering using state-of-the-art techniques. This includes advanced library cloning methods as well as medium to ultra-high-throughput screening methods. Two libraries will be cloned with different approaches yielding different numbers of variants, which will subsequently be screened with assistance of a robotic liquid handling station as well as a droplet sorting device.

Intended Learning Outcomes:
The students will gain insight into state-of-the-art enzyme engineering methods. After the course, they should be able to execute basic experiments with the demonstrated methods. They should be able to process, interpret and present data from large screening projects. Finally, they should have acquired the knowledge to choose a method for library generation based on the available possibilities and needs of the engineering project.

Teaching and Learning Methods:
Seminar presentation, active participation in experimental planning, lab-work, demonstration of advanced methods by trained scientists, guided evaluation of screening results

Media:
Seminar presentation, screening result files

Reading List:
course script and related scientific papers

Responsible for Module:
Prof. Volker Sieber

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

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

Module Description

CS0245: Advanced Electronic Spectroscopy | Advanced Electronic Spectroscopy

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The performance test will be in the form of a written examination. The students should demonstrate in the exam the understanding of the different techniques taught during the module.
No auxiliary means are allowed in the exam. 120 min examination time

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
This course will intend to consolidate concepts in Physics, Chemistry, and Instrumentation having the focus on articles utilizing the different techniques. As such, knowledge in Physics, Chemistry, and Instrumentation is required.

Content:
The module aims to provide in-depth knowledge to the students in electronic spectroscopy and its applications.
The module will critically evaluate optical spectroscopy techniques such as fluorescence, Uv-Vis absorption, Circular dichroism, photoacoustic spectroscopy, and circularly polarized luminescence focusing on their fundamental strength and weakness. Every method will be described following three main focuses: theory, material description, and applications.
Application examples will be from literature and journal articles.
The module will also continuously reinforce the theoretical background of the interaction between electromagnetic radiation and matter.

Intended Learning Outcomes:
At the end of the module, the students will have developed the ability to analyze advanced problems in electronic spectroscopy and associated phenomena. They will learn to evaluate

critically information regarding techniques such as fluorescence, Uv-Vis absorption, Circular dichroism, photoacoustic spectroscopy, and circularly polarized luminescence.

Teaching and Learning Methods:
This course attendance includes lectures and exercises. Additionally, in the module's final weeks, the student will be encouraged to create a presentation consisting of their critical analysis of a journal article. For this purpose, PowerPoint presentations, practical training materials, and open discussion seminars will be used.

Media:
The following forms of media apply Script, PowerPoint, films, and blackboards.

Reading List:
1. Physical Chemistry for the Life Sciences, 2ndEdition Peter Atkins and Julio De Paula Oxford University Press ISBN: 978-0-19-956428-6
2. Introduction to Biophotonics Paras N. Prasad Wiley 2003, ISBN: 0-471-28770-9.
3. Principles of fluorescence spectroscopy , Lakowicz, Joseph R., ed. . Springer science & business media, 2013.

Responsible for Module:
Costa Riquelme, Rubén Dario; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Electronic Spectroscopy (Lecture) (Vorlesung, 2 SWS)
Costa Riquelme R [L], Atoini Y, Costa Riquelme R, Gutierrez Armayor D

Advanced Electronic Spectroscopy (Exercise) (Übung, 2 SWS)
Costa Riquelme R [L], Atoini Y, Costa Riquelme R, Gutierrez Armayor D, Lipinski S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0261: Phytopharmaceuticals and Natural Products | Phytopharmaceuticals and Natural Products [Phytopharm]

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
Knowledge of the covered topics of phytopharmaceuticals and natural products compounds is assessed in a written examination (90 minutes). In addition, students are required to explain the medicinal effects of medicinal plants in the examination using examples.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Organic and anorganic chemistry, botany

Content:
Content of the lecture:
-definition of medicinal plants and phytopharmaceuticals
-position of phytopharmaceuticals in pharmacology
-compounding (tea drugs, soluble extracts, sCO2 extracts, steam destillation, pure substances)
-effect-determining components and frequent mechanisms (inflammation cascade, infections, coagulation system, neurotransmission, digestive system)
-typical medicinal plants grown in Europe
-international trade in medicinal plants
-important classes of compounds (terpenes, steroids, coumarine, alcaloids, vitamins, saccharides)
-quality determination and typical methods (chromatography)
-falsification and chemotype (chemical race)
-drug regulator affairs (authorisation, documents)
-use of medicinal plants in practice

Intended Learning Outcomes:
After their participation, students can explain the production of phytopharmaceuticals derived from typical medicinal plants (from collection to quality control). They can relate chemical compounds and medical effects of typical examples.

Teaching and Learning Methods:
The lecture takes the form of oral presentation given by teaching staff with the help of PowerPoint media, books and other written material.

Media:
PowerPoint presentation and printed handout. Laboratory equipment for experiments.

Reading List:
Deutschmann, F., Hohmann, B., Sprecher, E., Stahl, E., Pharmazeutische Biologie, 3 Bde., G. Fischer Verlag, 1992

Responsible for Module:
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

CS0262: Literature Seminar: Redox Enzymes in Electrobiotechnology | Literature Seminar: Redox Enzymes in Electrobiotechnology [Literature Seminar: EBT]

Version of module description: Gültig ab summerterm 2022

Module Level: 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 competence to conduct a literature search with digital methods, analysis of the state of the art and frame a subject specific question is to be demonstrated in the form of a presentation. For this purpose, groups of two are formed, whereby each of these groups is given a branch in the field of bioelectrochemistry. With the help of current literature, they should evaluate the state of the art and how to further develop this field by designing a novel research project. The results are presented and defended in a 20-minute oral presentation at the end of the term.

Repeat Examination:

(Recommended) Prerequisites:
Successful participation in the module "Einführung in die Elektrochemie" or “Advanced Electrochemistry” or consolidated knowledge in the field of electrochemistry and successful participation in the module “Enzyme und ihre Reaktionen” or “Enzymatic Biotransformations”.

Content:
This course focuses on the field of enzymes useful in electrobiotechnology and biophotoelectrochemistry. In particular, the structured analysis of publications found and an efficient evaluation according to their usefulness for one's own research question will be discusses. Additionally, the course will cover,
- detailed and critical examination of published results and the pitfalls of common measurement techniques.
- the submission and reviewing processes including templates/platforms for authors and for reviewers.

- review and presentation of various recent scientific discoveries in the field of bio(photo)electrochemistry.
- examples of current research projects including research proposals.
- development of novel projects and how to find a good working hypothesis.
- the process of turning the working hypothesis into a research proposal.

Intended Learning Outcomes:
After successful participation in this module, students will be able to:
- understand and analyse the structure of a scientific publication in the topic of redox enzymes in electrobiotechnology and biophotoelectrochemistry.
- critically assess the issues in the conculsion due to the methods used to investigate a given system.
- classify the literature found according to its quality and its usefulness for their own research question.
- evaluate the state of the art of redox enzymes used in electrobiotechnological and biophotoelectrochemical applications.
- based on the literature develop a research project with a novel working hypothesis.

Teaching and Learning Methods:
In this seminar, the students are supposed to analyse and evaluate given publications in the first weeks. In the seminar the findings are debated with a special focus on the issues and pitfalls due to the used measurement methods. The objective is to teach how the same measurement results can lead to different conclusions especially if not all features of a measurement method are considered. Supplementary presentations about submission processes and research proposals should teach how to develop and secure funding for a new research project.

Media:
Presentations, case studies, discussion rounds, Moodle course with discussion forum.

Reading List:

Responsible for Module:
Prof. Dr. Nicolas Plumeré Dr. Martin Winkler Dr. Vincent Friebe

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

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

Module Description

CS0264: Polymer Processing | Polymer Processing [PolyProc]

Processing of polymers intro plastic parts

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
The content and learning objectives of the lecture are examined at the end of the semester in a written test (90 min). An oral pre-test containing safety relevant laboratory work issues must be carried out before the individual pratical course. A written report on the practical course consisting of approximately five pages must be submitted. The written report is an ungraded student achievement.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Polymer chemistry, polymer physics, rheology fluid mechanics, Biogenic Polymers

Content:
The lecture deals with unit operations, basic techniques and processes of plastic material processing, e.g. compounding, extrusion, injection molding, plastic part forming processes and also typical applications. In addition, methods for characterizing thermal and mechanical properties are presented. One focus here is the connection between the processing parameters and the end-use properties. The acquired knowledge is deepened in the accompanying practical course. Injection molding and extrusion tests are carried out and the test specimens are then characterized with regard to their thermal, optical and mechanical properties. Additional foci will be laid on the chemistry, structure and classification of polymers and plastic parts. The lecture also deals with the physical properties of polymers and plastic materials involving materials science. Characterization of the mechanical and thermal properties and their effects on processing, viscosity, viscoelastic behavio will be discussed

Intended Learning Outcomes:
In addition to the chemical-physical basics of polymeric materials, this module imparts the methodical knowledge about classic and modern innovative processing methods of polymeric materials. The students are able to sensibly classify plastic materials, their manufacture and use them for specific applications. The basics for the production technology of plastic materials are acquired. After successfully completing the module, students are able to select and use methods for processing plastic. They will be able to assess sustainability aspects of the polymer production process in terms energy consumption and materials use. Through practical work, the competence for the meaningful use of testing and characterization methods of polymer materials is acquired.

Teaching and Learning Methods:
Lecture (lecture by teaching staff with Power Point slide media, books and other written material), laboratory practical course (experimentation of the students under supervision)

Media:
Power Point slide presentations; Drawing and writing on a black board; Laboratory equipment for experimentation

Reading List:
Polymer Engineering; Technologien und Praxis; Peter Eyerer, Peter Elsner, Thomas Hirth
Polymer Extrusion; Chris Rauwendaal
Extrusion: The Definitive Processing Guide and Handbook; Harold F. Giles, Jr.
Einführung in die Kunsstoffverarbeitung; Michaeli, W.
Werkstoffkunde der Kunststoffe; Menges, G.

Responsible for Module:
Prof. Cordt Zollfrank

Courses (Type of course, Weekly hours per semester), Instructor:
Polymer Processing (Lecture) (Vorlesung, 2 SWS)
Zollfrank C [L], Fang W, Helberg J

Polymer Processing (Practical) (Praktikum, 1 SWS)
Zollfrank C [L], Fang W, Helberg J
For further information in this module, please click campus.tum.de or here.

Module Description

CS0265: Biorefinery | Biorefinery [BioRaff]

Version of module description: Gültig ab winterterm 2025/26

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

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

Description of Examination Method:
Students answer questions in a written examination (60 minutes) that will be graded. They thereby show that they have understood, can explain and are able to assess the various steps and processes involved in biorefinery. In an additional voluntary coursework (Mid-term), which is not part of the written exam, students individually study selected topics in the field. Here, they apply their knowledge acquired in lectures to deduce and/or evaluate processing methods. Findings are presented in a "research paper" or a short presentation (5 min). Bonus points (up 10/60 depending on the quality) will be awarded for the coursework on the written exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in chemistry and biology; Module "Renewables Utilization"

Content:
Contents of the module include:
comparison of biorefinery and mineral oil refinery; role of biorefineries for the development of a sustainable biobased economy; presentation and analysis of different biorefinery systems (e.g. green biorefinery, lignocellulose biorefinery);
selected procedures for the extraction of resources (focused on lignocellulose);
selected biogenic compounds for further processing (e.g. saccharides, lipids/oils, lignin);
selected pathways of their use (e.g. bioalcohols, polylactic acid, proteins, succinate and other components);
cascade use of materials and energy.

Intended Learning Outcomes:
After completion of the course, students will have understood the concept of biorefinery, analogous to and in contrast with mineral oil refinery. Students are able to describe various biorefinery concepts and methods for processing renewable resources in biorefineries. The understand the importance of biorefineries for a future sustainable biobased economy. They are able to apply their knowledge to the analysis and assessment of viable biorefinery systems, taking into account their respective advantages and disadvantages. In addition, they have trained their competences in literature research and critical evaluation as well as in the preparation of "research papers".

Teaching and Learning Methods:
Lecture: talks given by teaching staff; Exercise: more detailed studies on selected topics; students individually prepare one topic and finally present their results ("research paper").

Media:
PowerPoint presentation, blackboard

Reading List:
B. Kamm, P. R. Gruber, M. Kamm (Hrsg.), Biorefineries - Industrial Processes and Products, Vol. 1-2, Wiley-VCH, Weinheim, Germany, 2006

Responsible for Module:
Doris Schieder (doris.schieder@tum.de)

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

Biorefinery (Seminar) (Seminar, 1 SWS)
Schieder D
For further information in this module, please click campus.tum.de or here.

Module Description

CS0266: Sustainable Chemistry | Sustainable Chemistry

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
The examination will take the form of a written test (60 minutes). In this examination the competence for the evaluation of chemical processes and for the derivation of optimization strategies shall be proven. No aids are permitted in the written examination. In order to additionally check whether the students are able to communicate scientific topics in front of an audience and whether they are able to critically deal with problems in individual steps, the results of the processing of the case studies are presented in the form of a 20-minute presentation alone or in a group. This presentation is ungraded study achievement.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the module "Basics in chemistry" or comparable knowledge in chemistry.

Content:
The module teaches basic principles of sustainable chemistry. Focus is set on the evaluation of chemical processes in view of efficiency, atom economy and amount of waste. In addition, optimizsation strategies related to catalytical methods, raw material and energy efficiency are discussed. Students individually prepare current topics related to sustainable chemistry and present them in the seminar.

Intended Learning Outcomes:
By attending the module events, students are able to highlight the principles of sustainable chemistry. Students can analyze the efficiency and waste quantities of chemical reactions and evaluate various alternative processes. Furthermore, they are able to discuss further chemical aspects of the conversion of renewable raw materials into valuable products. Through the

independent development of case studies, the students master all the steps that are important in the critical examination of problems (consideration of the example, development of criteria for evaluation, assessment, presentation of the results to an audience).

Teaching and Learning Methods:
Lecture with board addresses and presentations: Basic development and derivation of technical contents; seminar with written tasks. Consolidation of the technical learning contents through learning activity of the students themselves, e.g. through independent development of case studies from the field of sustainable chemistry.

Media:
Presentation, script, examples

Reading List:
Stanley E. Manahan: Green Chemistry, ISBN: 0-9749522-4-9

Responsible for Module:
Prof. Cordt Zollfrank

Courses (Type of course, Weekly hours per semester), Instructor:
Sustainable Chemistry (Seminar) (Seminar, 1 SWS)
Zollfrank C [L], Helberg J, Zollfrank C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0268: Applied Process Engineering | Applied Process Engineering [APE]

Applied process engineering

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The examination is performed in the form of a written examination (60 minutes). The students prove that they can solve arithmetic problems and apply methods of cost estimation and economic feasibility studies of process engineering processes as well as answer questions about optimization and cost reduction in writing.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Apparatus and plant construction, bioprocess engineering, chemical reaction technology, thermal process engineering

Content:
The module teaches the basics that are necessary for estimating costs and assessing the profitability and sustainability of a production process. Various methods of cost estimation are taught, as well as their suitability and accuracy in different project phases. The contents are in particular the following:

- Project/design phases (proof of principle, process development in the laboratory, piloting, demonstration, concept study, basic engineering, detail engineering, construction, commissioning, production, debottlenecking)
- Cost estimation (methods, including the Monte Carlo method, accuracy, process variants, sensitivity analyses, tornado plots)
- Assessment of Sustainability

- Investment versus CMO production
- Site selection and plant size
- permits
- Time plans
- Selected examples from industry
- (Operational) optimization and Lean Six Sigma tools
- Business Case Evaluation (Payback, Discounted Cash Flow, Net Present Value, Sales at Maturity)

Intended Learning Outcomes:
After participating in the module, the students are able to estimate operating and investment costs in the respective design phases for a production plant and to reduce production costs during the operation of a plant.

Teaching and Learning Methods:
In the lecture, the essential basics are presented and worked out. The content learned is applied to concrete practical questions in the exercise. Special software for cost estimation is learned in a computer exercise and sample calculations are carried out. Individual topics are worked on and presented in groups. After participating in the module, the students are able to apply the basics of cost estimation and to evaluate the profitability and sustainability in different project phases.

Media:
Presentations, interactive quizzes, case descriptions, computer exercises with software

Reading List:
Peters, M. S., Timmerhaus, K. D., West, R. E., 2003. Plant Design and Economics for Chemical Engineers. McGraw-Hill Education. ISBN 9780072392661

Vasudevan, P. T., Ulrich, G. D., 2004. Chemical Engineering Process Design and Economics: A Practical Guide. United States: Process Pub.. ISBN 9780970876829

Penney, W. R., Couper, J. R., Fair, PhD, J. R., 2012. Chemical Process Equipment: Selection and Design. Netherlands: Elsevier Science. ISBN 9780123969590

Towler, G., Sinnott R., 2021. Chemical Engineering Design - Principles, Practice and Economics of Plant and Process Design. Elsevier. ISBN 9780128211793

Chmiel, H. Bioprozesstechnik. (2011). Germany: Spektrum Akademischer Verlag. ISBN 9783827424761

Responsible for Module:
Michael Zavrel

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

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

Module Description

CS0273: Electrochemical Modelling | Electrochemical Modelling [ECM]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The learning results are demonstrated in form of a project. The students pick a topic of their interest in electrochemical modelling from a prepared selection. The students present this topic to their peers in the form of an 20 minute long oral presentation (+10 min discussion). In explaining their chosen topic, the students should utilize one or more of the methods learned in this course. After four weeks the student's work is present and evaluated. The student is graded based on his/her progress and approach presented in the oral summary.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
The student should know general chemistry, physics, and mathematics. Furthermore, a good knowledge of physical chemistry and electrochemistry is necessary. A basic knowledge of computer programming i.e., MATLAB is preferable.

Content:
- Physical models: continuum approximation, conservation laws, constitutive relationships, boundary conditions and the current distribution, microscopic models of electrode kinetics.
- Formulation and approximation: scaling and dimensional analysis, dimensionless groups.
- Steady-state systems: modelling voltammetry under steady reaction-diffusion, methods for solving linear systems, approximate/asymptotic methods for non-linear reaction kinetics.
- Transient systems: modelling transient potential step chronoamperometry and cyclic voltammetry with and without reactions.
- Numerical methods: approximations for first and second derivatives, explicit and implicit methods.

Intended Learning Outcomes:
The students understand the basic concepts of modelling electrochemical systems, focusing on a breadth of analytical and numerical methods applicable to solving a wide range of different systems. Furthermore, they are able to identify key processes and boundary conditions and translate these into mathematical expressions. Thus, they can systematically implement simplifications to model complex electrochemical phenomena. Importantly, they can formulate a problem and find an approximate solution using scaling, dimensionless groups, and dimensionality reduction. In particular, they can analyse and distinguish between various electrochemical methods and know how to model these. Overall, they succeed in planning and constructing their own mathematical models, which they can solve either analytically or numerically to find the current response, while reviewing and evaluating their assumptions for deriving the governing mathematical equations.

Teaching and Learning Methods:
The teaching content is presented with lectures, text documents, PowerPoint presentations, and blackboard sketches. This enables a way of delivering the teaching content to the students in detail and answering questions as soon as they arise. PowerPoint slides and blackboard sketches add visual assistance to understand the complex relationships in electrochemistry and how to express these relationships in terms of mathematical equations. Additionally, the students are provided with exercises to consolidate what they have learned in the lecture with hands-on modelling examples and reviewing the mathematical tools necessary to solve the equations. The exercises and solution are discussed and explained in the practical lessons.

Media:
Presentations, PDF-script, case studies and algorithms for models in MATLAB.

Reading List:
R. G Compton, E.Laborda, K. R. Ward, Understanding Voltammetry: Simulation of Electrode Processes.
J. M. Savéant, C. Costentin, Elements of Molecular and Biomolecular Electrochemistry.
A. J. Bard, L. R. Faulkner Electrochemical Methods: Fundamentals and ApplicationsElectrochemical Methods: Fundamentals and Applications.

Responsible for Module:
Ben A. Johnson

Courses (Type of course, Weekly hours per semester), Instructor:
Electrochemical Modelling (Übung, 2 SWS)
Johnson III B [L], Buesen D

Electrochemical Modelling (Vorlesung, 2 SWS)
Johnson III B [L], Johnson III B
For further information in this module, please click campus.tum.de or here.

Module Description

CS0305: Research Excursion Master | Research Excursion Master

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
Passed/not passed:
The module is passed when the students deliver a learning portfolio consisting of the following elements::
1. 2 written pages or 20' presentation on preparatory work for the excursion. The form and the due date will be specified in the kick-off session.
2. At least two topical contributions to the excursion (topical input, interviews, questions on presentations and during site visits, discussion contributions;
3. 5-10 PPT slides reflecting the findings based on a case study visited during the excursion. The due date will be specified in the kick-off session;
4. Final report of case studies and results of the workshop;

All four elements of the learning portfolio have to be delivered to pass the module.

Repeat Examination:

(Recommended) Prerequisites:
Prerequisites may be defined by the professors / lecturers offering the excursion, dependent on the chosen destination / topic. They will be announced with the announcement of the excursion 1 month before the start of lectures in the semester in which the excursion is offered, at the latest.

Content:
The research excursion deals with individual topics from modules and / or the study programs for which it is designed. On an individual basis, professors and lecturerers from these modules / study programs offer the research excursion to a topic or place of their choice.

A bullet point list with typically 10-12 entries will be provided by the professors and lecturers with the announcement of the research excursion 1 month before the start of lectures in the semester in which the excursion is offered, at the latest.

After the excursion the results of the applied methodologies are presented and discussed in a workshop. Key findings and the results of the workshop are included in a final excursion report by the students.

Intended Learning Outcomes:
The excursion aims to support the scientific profile building of students and the acquisition of scientific, practical and social competencies and the application to case studies visited during the excursion. It supports the competence acquisition in other modules and / or the study programs in general. The students get practical insights into the topical field of the research excursion, deepen their comptencies in this field regarding ongoing research and apply their competencies to real case studies in practice.

In particular, the intended learning outcomes are the following:
- Select relevant scientific and practical information and recall it for for visits of organizations, cities and talks with experts and stakeholders,
- Prepare questions regarding the state-of-knowledge, open research questions and practical relevance and discuss these with fellow students,
- Discuss research and practical knowledge with stakeholders,
- Recognize the implementation of research and practical knowledge in the organisations / sites visited,
- Reflect on the state of implementation of theoretical knowledge in practice,
- Discuss with fellow students and supervisors gained insights and compare it with their expectations,
- Perform structured interviews and talks with experts and stakeholders in practice
- Apply methodologies from theoretical lectures and exercises on practical organizations

Teaching and Learning Methods:
The research excursion consists typically of the following elements (teaching, learning and application of methods):
- Kick-off session: To achieve a good get-to-know, brief the students about the module contents, course and required performance an interactive in-presence workshop will be carried out. This covers presentations, and interactive elements such as role games etc.
- Individual work and feedback: In order to prepare for the on-site visits the students carry out own literature research on the excursion topics. To document their learning progress and to be able to share the results they summarize their findings in written form. A presentation of the contents in front of the fellow students is an optional element. In this process, they are supervised, receive materials and continuous feedback.
- On-site visits: 3-5 day research trip with site-visits, presentations, discussions with stakeholders, interviews of experts etc. This part will be specified in the specific program of the research

excursion and can due to the variety of possible destinations and topics not be specified further at this point.
- Individual work: the students will reflect their learnings in written form,
- Workshop: the students will present and discuss their findings in a workshop to gain practical experience for their future working conditions and formulate a final excursion report.

Media:
Digital projector, board, flipchart, online contents, recent scientific journal publications, equipment and utilities demonstrating production processes in practice

Reading List:
Topic related reading, especially articles in international peer reviewed journals, will be provided during the course of the module.

Responsible for Module:
Prof. Cordt Zollfrank Prof. Hubert Röder Prof. Magnus Fröhling

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

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

Module Description

CS0311: Mechanical Processing of Biogenic Materials | Mechanical Processing of Biogenic Materials [MVTbM]

Mechanical Process Engineering biogenic Materials

Version of module description: Gültig ab summerterm 2025

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 the form of a written examination (90 minutes).
The students prove that they can solve computational problems and apply methods of biogenic particles and processing as well as answer questions about plants and apparatuses of mechanical process engineering.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic of Thermodynamics, Reaction Technology, Heat Transfer, Fluid Mechanics

Content:
The module provides the necessary basics for the description of particle systems in general and with a focus on biogenic particles
(particle size and shape, distribution functions, particle movement and interactions in bulk solids).
The basic operations applied to particles are presented: Production, comminution, mixing, separation, agglomeration, fixed and fluidized beds, filtration. For example, applications in the materials and energy industry in fiber technology, wood size reduction, conveying, stirring and combustion of biomass are discussed.

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 a lecture and a tutorial.
The contents of the module are conveyed in the lecture by means of papers and presentations. Students are encouraged to actively engage with the topics by integrating various tasks for self-research and comprehension questions. In the exercises, which take place alternately with the lecture, the understanding of the course content is deepened. Students work through various calculation tasks.

Media:
Presentations, scripts, exercises

Reading List:
Rhodes, M.J., 2008. Introduction to particle technology. 2nd ed. Chichester, England: Wiley. ISBN 047072711X.

Responsible for Module:
Matthias Gaderer, Wen Wen

Courses (Type of course, Weekly hours per semester), Instructor:
Mechanical Processing of Biogenic Materials (Exercise) (Übung, 2 SWS)
Gaderer M [L], Gaderer M, Huber B

Mechanical Processing of Biogenic Materials (Lecture) (Vorlesung, 2 SWS)
Gaderer M [L], Gaderer M, Huber B
For further information in this module, please click campus.tum.de or here.

Module Description

CS0314: Sustainable Fibre Technologies | Sustainable Fibre Technologies [SFT/P]

Sustainable fibre technology

Version of module description: Gültig ab summerterm 2025

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

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

Description of Examination Method:
Assessment takes the form of a written examination (120 minutes).
The students can demonstrate their ability to distinguish the chemo-physical, structrual and mechanical differences between various natural fibres, processed biopolymer fibre and regenerate fibres. They can describe basic sustainable fibre process technologies and fibre applications, and can answer questions regarding sustainable fiber spinning technologies.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Organic Chemistry, Polymer Chemistry, Chemical- & Thermal Process Engineering, Mechanical Processing of biogenic Materials,
Biogenic Polymers

Content:
The module provides an overview of fundamental production methods for biogenic and biodegradable fiber and their processing, covering the fibre structures and mechanical properties. The module introduces various fiber spinning technologies and guides on selecting appropriate methods for converting different bio-based polymers into fibers. The course also explores the applications of natural and biodegradable polymers in various industries, including textiles, packaging, and composites. Furthermore, it briefly covers material characterization methods for natural and biogenic fibers and their fibre composites.

Intended Learning Outcomes:
After completing the module, students will be able to evaluate the properties and applications of various natural fibers, synthetic and regenerated fibers made from biodegradable polymers. They will be able to explain the most important fibre spinning technologies and the most important characterization methods for fibres.

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.

Media:
Presentations, scripts, exercises

Reading List:
- Dieter Veit; 2022. Fibers: history, production, properties, market. Weinheim: Springer. ISBN 978-3-031-15308-2, ISBN 978-3-031-15309-9 (eBook).
- Vijay Kumar Thakur and Manju Kumari Thakur, 2015. Handbook of sustainable polymers: processing and applications. Taylor & Francis Group.
- Sabu Thomas, Ajitha AR, Cintil Jose Chirayil, Bejoy Thomas, 2023 Handbook of biopolymers. Springer. ISBN 978-981-19-0709-8, ISBN 978-981-19-0710-4 (eBook)
- David Plackett, 2011, Biopolymers – New Materials for Sustainable Films and Coatings, John Wiley and Sons. ISBN 9780470683415

Responsible for Module:
Wenwen Fang

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

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

Module Description

CS0316: Bioprocess Scale-Up | Bioprocess Scale-Up [BSU]

Bioprocess Scale-up

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The learning content is checked by means of a written examination on the learning outcomes of the module. The written examination lasts 60 minutes. Using questions on terms and methods of scaling up bioprocesses, the students show that they know the relevant technical terms, names and content, that they have understood the basic relationships and can apply their knowledge. Using calculations, the students also show that they can calculate the scale up.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bioprocess Engineering
Conceptual Design of Bioprocesses

Content:
Biopharmaceuticals, enzymes, biological cell materials or food supplements are all derived from the cultivation of bacteria, yeasts, fungi, plant or animal cells in bioreactors. Regardless of what kind of bioprocess is used for, efficiencies of time and cost and other resources are major factors to consider. These bioprocesses are usually developed at small laboratory scale. Later, the established processes are stepwise transferred to larger volumes until the commercial industrial production-scale is reached. This procedure is known as scale-up.
To reach this goal different scale-up strategies can be applied. The objective of this course is to provide the students with the necessary and fundamental insight involved in scaling-up biotechnological processes from laboratory-scale to industrial-scale. Important methods, concepts, and tools are introduced which lay the basis for scaling up of biochemical processes. First, introduction into scaling laws will be given, followed by the introduction into general scale-up methods. Afterwards needs and challenges of scaling up bioprocesses will be discussed and

various strategies introduced. Finally, emerging trends and challenges will be discussed. Through a combination of theoretical concepts, practical examples, and real-world case studies, this lecture aims to enable participant to develop suitable scale-up strategies in future.
By the end of this lecture, participants will be equipped with the knowledge and insights necessary to navigate the challenges and seize the opportunities presented in the field of bioprocess scale-up.

Intended Learning Outcomes:
Upon completion of the course, the students are able to:
- Know fundamentals of scaling-laws
- Know fundamentals of scale-up strategies
- Have necessary knowledge and tool-sets for scaling-up bioprocesses
- Be aware of potential pitfalls during scale-up
- Know best practices for scale-up

Teaching and Learning Methods:
The lecture is mainly conducted as frontal teaching in order to familiarize the students with all the necessary basics that they need for the scale-up of sustainable processes in the field of biotechnology. Calculation exercises are included into the lecture.

Media:
Slides, interactive quiz, films, script, exercises

Reading List:
Marko Zlokarnik, Dimensional Analysis and Scale-up in Chemical Engineering, https://doi.org/10.1007/978-3-642-76673-2

Responsible for Module:
Prof. Dr.-Ing. Michael Zavrel Prof. Dr.-Ing. Alexander Grünberger (external - KIT)

Courses (Type of course, Weekly hours per semester), Instructor:
Bioprocess Scale-Up (Vorlesung mit integrierten Übungen, 2 SWS)
Zavrel M [L], Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0319: Electrochemical Process Engineering | Electrochemical Process Engineering

Version of module description: Gültig ab summerterm 2025

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

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

Description of Examination Method:
The assessment consists of a 90-minute written exam that includes short questions and exercises designed to test both an understanding of scientific principles and proficiency in the engineering design process. Students are permitted to bring two double-sided DIN A4 pages of handwritten or printed notes to assist them in answering the exam questions. Students are also allowed a non-programable calculator, pens and pencils, and a ruler.

Repeat Examination:

(Recommended) Prerequisites:
Many fundamental concepts of thermodynamics, electrochemistry, and process engineering will be revisited at the start of the module.

However, having an engineering background or having completed one or more of the engineering modules offered on campus, such as Introduction to Process Engineering, Chemical and Thermal Process Engineering, Applied Process Engineering, or Energy Process Engineering, is advantageous for prospective students.

Furthermore, prior knowledge in thermodynamics or electrochemistry—ideally obtained through completing the Basics of Thermodynamics or the Introduction to Electrochemistry module—is advantageous for prospective students.

Content:
The module includes but is not limited to the following content:
- Fundamentals of thermodynamics and electrochemistry
- Fundamental process engineering calculations

- Electrolysis technologies
- Fuel cell technologies
- Basic design calculations for electrolysis and fuel cell technologies
- Industrial electrochemical processes
- Basic design calculations for electrochemical processes
- Energy efficiency calculations for electrochemical processes
- Techno-economic calculations of electrochemical processes
- Case studies: Power-to-Hydrogen and Power-to-Methanol processes
- Process simulation workshop
- Current frontiers in electrochemical process engineering

The contents of the module are organized into seven main sections:

1. Introduction
2. Revisiting the fundamentals
3. Electrolysis and fuel cell technologies
4. Designing electrochemical processes
5. Evaluating electrochemical processes
6. Case studies
7. Frontiers in electrochemical process engineering

Intended Learning Outcomes:
With successful completion of the module, the students should be able to:

- Understand electrochemical processes and their importance in the evolving industrial landscape
- Understand the operating principles of electrolysis and fuel cell technologies (PEM, Alkaline, SOC)
- Analyze and design electrolysis and fuel cell technologies with basic calculations
- Analyze and design electrochemical processes with basic calculations
- Evaluate the efficiency and economic aspects of electrochemical processes
- Understand the current frontiers in electrochemical process engineering

Teaching and Learning Methods:
The module comprises lectures, tutorials, and one process simulation workshop. The lectures introduce key concepts and methods, providing students with an understanding of how to design and analyze electrochemical processes. The tutorials focus on practical exercises that guide the students in designing different aspects of electrochemical processes. The workshop teaches the students to use process simulation software to carry out the complex calculations required to simulate an electrochemical process.

Media:
The majority of the sessions will be conducted online, with a small number of sessions held on campus. Lecture notes and tutorial exercise solutions will be made available to the students;

however, video recordings of the lectures and tutorials will not be provided. The software used in the process simulation workshop is free to download and open source.

Reading List:

1. Electrochemical Process Engineering: A Guide to the Design of Electrolytic Plant, F. Goodridge, K. Scott, 1995, Springer New York.

2. Sustainable Hydrogen Production, I. Dincer, C. Zamfirescu, 2016, Elsevier.

3. Electrochemical Engineering, T. F. Fuller, J. N. Harb, 2018, Wiley.

4. Electrochemical Engineering: Science and Technology in Chemical and Other Industries, H. Wendt, G. Kreysa, 1999, Springer.

5. Basic Principles and Calculations in Chemical Engineering, D. M. Himmelblau, J. B. Riggs, 2023, Pearson.

Responsible for Module:

Leandros Paschalidis (l.paschalidis@fz-juelich.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

CS0320: Biofilms and Biofouling | Biofilms and Biofouling [BiofBiof]

Version of module description: Gültig ab summerterm 2025

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 120	**Self-study Hours:** 30	**Contact Hours:** 90

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

Description of Examination Method:
The exam lasts 60 minutes. Students should be familiar with the topics covered in the lecture and be able to name and explain their knowledge of biofilms and biofouling. Calculations and interpretation of measurements from biofilm research will be carried out in a similar way to the examples given in the lectures. The results of the group work are part of the examination and should be discussed and evaluated using the terminology learned.
Participation and collaboration in the working groups is a mandatory requirement for the exam. However, this work will not be assessed and will not count towards your final grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
The Biofilms and Biofouling module focuses on the formation, maturation and spread of biofilms. It also covers their structure, composition and the microbiological principles needed to better understand and assess their occurrence. Practical examples are used to discuss the existence of beneficial biofilms and harmful biofouling. The resulting consequences are also discussed and demonstrated for each topic, so that ultimately prevention and control can also be evaluated.

Intended Learning Outcomes:
After completing the module 'Biofilms and Biofouling', students will be able to give examples of the occurrence of biofilms and explain their formation and composition. They will be equipped to describe and classify the nutritional requirements and behaviour of various prokaryotic and eukaryotic organisms based on the microbiological principles they have learnt. This knowledge will then enable students to consider and evaluate the use and control of biofilms. Lecture-based

exercises and small group work will also help students to deepen their knowledge so that they are capable of giving a scientifically based presentation on their group topic.

Teaching and Learning Methods:
The module consists of two parts: a lecture with integrated exercises and a project part in which students work on their own topics in small interdisciplinary groups. PowerPoint presentations, quizzes, films, pictures and books are used as needed to teach the students, partly through lectures but also through collaborative work on the black or white board.

Media:
Media types include scripts, PowerPoint, quizzes, films and sample objects. Participants work on their own projects in small, interdisciplinary groups.

Reading List:
DONELLI, Gianfranco (Hg.). Microbial biofilms: methods and protocols. New York, NY, USA:: Humana Press, 2014.
KANEMATSU, Hideyuki; BARRY, Dana M. Formation and control of biofilm in various environments. 2020.

Responsible for Module:
Gmach, Yvonne; Dr. rer. nat.

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

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

Module Description

CS0322: Advancements in Fiber Production, Recycling, and Applications | Advancements in Fiber Production, Recycling, and Applications [AFP]

Version of module description: Gültig ab winterterm 2025/26

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 120	**Self-study Hours:** 90	**Contact Hours:** 30

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

Description of Examination Method:
Assessment takes the form of a written 10-15 pages report, supplemented with an 10 min (8 min + 2 min questions) oral presentation. The report weighted for 80% and presentation weighted for 20% for the final exam. Students will show their abilities to conduct a literature review on the properties of natural and synthetic polymers, along with polymeric composites. Likewise, students will be capable of describing several spinning techniques and fibers' functionalization, choosing the optimum technique and polymeric composition for a specific application.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Polymer Chemistry, material science, biopolymers

Content:
This seminar course covers an overview of the most commonly used natural and synthetic polymers for producing fibers, also including possible polymeric blends. Additionally, several spinning techniques will be addressed, focusing on their parameters and several applications. Students will also be guided on the potential functionalization of fibrous constructs for the enhancement of relevant properties (e.g., mechanical, antimicrobial).

Intended Learning Outcomes:
Upon completion of this module, students will understand the different spinning techniques, along with comparing several polymeric composites and functionalization strategies. Students should also develop a critical thinking towards creating alternative and eco-friendly solutions of fibrous constructs for a wide range of applications.

Teaching and Learning Methods:
The module consists of seminars and question and answer (Q&A) sessions. The contents of the module will be covered during the seminars by speech and oral presentations. The Q&A sessions will be planned according to the students' needs, towards guiding them to successfully prepare their report and final presentation.

Media:
Presentations

Reading List:
Mirabedini A. (2017). Developing novel spinning methods to fabricate continuous multifunctional fibres for bioapplications [Doctoral dissertation, University of Wollongong]. University of Wollongong Thesis Collections. https://ro.uow.edu.au/theses1
Lewin M. (2007). Handbook of Fiber Chemistry (third edition). CRC Press Taylor & Francis Group.
Rajput V.S., Bhinder J. (2024). Advanced Materials for Biomedical Applications. Springer.

Responsible for Module:
Wenwen Fang, Catarina Miranda

Courses (Type of course, Weekly hours per semester), Instructor:
Advancements in Fiber Production, Recycling, and Applications (Seminar, 2 SWS)
Fang W [L], Fortuna dos Santos Miranda C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0327: Microenergy Harvesting and Conversion for a Sustainable Future | Microenergy Harvesting and Conversion for a Sustainable Future [MH]

Version of module description: Gültig ab summerterm 2025

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

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

Description of Examination Method:
The performance test for this course will be a 120-minute written examination. Students will be required to demonstrate their understanding of the physicochemical principles underlying energy conversion systems and the structure of biomolecules. The exam will emphasize the application of fundamental physical chemistry concepts to energy-harvesting mechanisms and the material properties of both natural and engineered systems. No supplementary materials will be allowed during the examination.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
While no formal prerequisites are required, prior coursework in physical chemistry, materials science, or nanotechnology is recommended, along with skills in analyzing scientific literature.

Content:
This course provides a detailed introduction to the principles, materials, and technologies involved in microenergy harvesting. Students will learn about the process of converting ambient energy from mechanical, thermal, light, and electromagnetic sources into usable electrical energy. Key topics include energy harvesting methods such as thermoelectric, piezoelectric, triboelectric, photovoltaic, and RF systems, as well as less conventional approaches like water interaction-based and biobased energy harvesters. The course focuses on the design, improvement, and application of energy harvesting systems, with an emphasis on materials like nanostructures, thin films, and biodegradable components. Students will also study how to integrate energy storage, fabrication techniques, and ways to improve efficiency and durability. Real-world uses

will be explored, including powering IoT devices, wearables, and technologies built for extreme environments, along with the challenges of scaling up these systems.
Through lectures, discussions, and reviews of recent scientific advancements, students will develop the skills to evaluate energy harvesting technologies and apply what they learn to design practical, sustainable solutions for modern energy challenges.

Intended Learning Outcomes:
By the end of this course, students will understand how microenergy harvesting works and how it is used to convert ambient energy—mechanical, thermal, light, and electromagnetic—into usable electricity. They will also learn why it is important for powering IoT devices, wearable electronics, and other low-power systems. Students will study the performance of key energy harvesting technologies, such as thermoelectric, piezoelectric, triboelectric, photovoltaic, and RF systems, along with less common methods like water-based and biobased approaches. They will look at the potential uses of these technologies and the challenges they face. Students will also learn about advanced ways to make these devices and explore the difficulties of scaling them up for real-world applications. In addition, they will look at the reliability, durability, and new trends in microenergy harvesting research.

Teaching and Learning Methods:
The lecture will follow a traditional format, using PowerPoint presentations to explain core concepts and including examples from scientific literature to provide practical context and highlight key ideas. The seminar will take a blended active learning approach, combining traditional exercises that reinforce technical concepts with creative activities, such as infographics, short films, and visual presentations, to build communication skills. It will also include debates and case study discussions to encourage critical thinking, teamwork, and a balanced understanding of the strengths and weaknesses of emerging technologies

Media:
The course will primarily use PowerPoint presentations, supported by examples from scientific literature and exercise sheets. Multimedia resources, such as videos and online platforms, will provide interactive learning, while seminars will include visual aids like infographics and creative presentations to enhance engagement.

Reading List:
1. Atkins' Physical Chemistry 8th Edition Peter Atkins and Julio De Paula, Oxford University Press, 2006, ISBN: 0-7167-8759-8
2. Energy Harvesting Technologies, 1st Edition Shashank Priya, Daniel J. Inman, Springer, 2008, ISBN: 978-0-387-76463-4
3. Materials Science and Engineering: An Introduction, 7th Edition William D. Callister, Wiley, 2007, ISBN: 978-0-471-73696-7
4. Electronic Properties of Materials, 4th Edition by Rolf E. Hummel, Springer, 2011 ISBN: 978-1-4419-8163-9

Responsible for Module:
Dr. Anna Zieleniewska

Courses (Type of course, Weekly hours per semester), Instructor:
Microenergy Harvesting and Conversion for a sustainable Furture (Lecture) (Vorlesung, 2 SWS)
Costa Riquelme R, Zieleniewska A

Microenergy Harvesting and Conversion for a Sustainable Furture (Exercise) (Übung, 2 SWS)
Costa Riquelme R, Zieleniewska A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0332: Environmental Technology | Environmental Technology [EnTe]

Version of module description: Gültig ab winterterm 2025/26

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

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

Description of Examination Method:
The exam lasts 60 minutes. Students should be familiar with the topics covered in the lecture and be able to name and explain their knowledge of environmental technology. Calculations and interpretations of measurements from environmental technology are carried out in the same way as the examples presented in the lectures. The necessary physical fundamentals are assumed, but are also repeated during the lecture. The terminology learned should be used to answer the questions in the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The lecture provides students with a broad overview of the subject of environmental technology. After a general introduction to the topic, environmental policy and environmental protection are examined, including the relevant authorities, responsibilities and legal framework. This is followed by ecological principles and interrelationships relating to the main topics of soil, air and water, in order to bring all students to the same level of prior knowledge. The main focus is on the different types of environmental pollution, their occurrence and spread, and the applicable limit values. Subsequently, the various technical processes for eliminating environmental pollution are discussed. A special focus of the lecture is on biological processes for pollutant removal and the reduction of environmental pollution. The equipment and methods developed for this purpose are presented. Particular attention is paid to the microorganisms/biofilms required for this purpose and their special properties in the degradation of pollutants. In addition, measurement methods are presented with which the success of the cleaning process can be verified. Finally, the various methods for preventing environmental pollution are discussed.

Intended Learning Outcomes:
After completing the lecture ‘Environmental Technology’, students will have a basic understanding of environmental and climate problems, their causes and protective measures. They will be able to name the legal regulations (Germany) and waste, water, air and soil and know the responsible authorities. Participants will gain an understanding of environmentally friendly measures for energy use and processes for removing pollutants from water, air and soil, as well as various measurement methods. The lecture places a particular focus on innovative biological processes that use microorganisms and biofilms to clean the environment. Students also learn about various measurement methods, limit values and the limitations of these methods. This gives them an understanding of environmental processes and enables them to assess environmental problems and discuss ways of avoiding them in the future.

Teaching and Learning Methods:
PowerPoint presentations, quizzes, films, images and books are used in class as needed. This is done partly in the form of lectures, but also through joint work on the blackboard or whiteboard. Where possible, small group work is assigned during the lecture and the results are then discussed together.

Media:
Media types include scripts, PowerPoint, quizzes, films and sample objects.

Reading List:
German books:
Einführung in die Umwelttechnik - Grundlagen und Anwendungen aus Technik und Recht; https://link.springer.com/book/10.1007/978-3-322-83867-4
Praxiswissen Umwelttechnik — Umweltmanagement - Technische Verfahren und Betriebliche Praxis; https://link.springer.com/book/10.1007/978-3-322-84908-3
Umwelttechnik: Ein Lehr- und Übungsbuch; https://www.google.de/books/edition/Umwelttechnik/0NvVEAAAQBAJ?hl=de&gbpv=0
Anaerobtechnik; file:///C:/Users/ga73vub/Downloads/b137857.pdf
Books in English:
Handbook of Environmental Engineering
https://onlinelibrary-wiley-com.eaccess.tum.edu/doi/book/10.1002/9781119304418#aboutBook-pane
Sustainable Approaches to Environmental Design, Materials Science, and Engineering Technologies
https://link-springer-com.eaccess.tum.edu/book/10.1007/978-3-031-76025-9
Sustainable Energy and the Environment: A Clean Technology Approach
https://link-springer-com.eaccess.tum.edu/book/10.1007/978-3-319-29446-9
Applied Environmental Biotechnology: Present Scenario and Future Trends
https://link-springer-com.eaccess.tum.edu/book/10.1007/978-81-322-2123-4

Responsible for Module:
Dr. Yvonne Gmach

Courses (Type of course, Weekly hours per semester), Instructor:
Environmental Technology (Vorlesung, 2 SWS)
Gmach Y
For further information in this module, please click campus.tum.de or here.

Module Description

CS0340: Computer Methods for Process Engineers | Computer Methods for Process Engineers [CMPE]

Version of module description: Gültig ab winterterm 2025/26

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:
Oral exam (20-30 min). Candidates are presented with process-engineering problems that would require computer assistance. The exam assesses whether they choose and apply the appropriate methods correctly.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Ability and a passion for computer coding, a basic understanding of numerical methods (e.g., Euler's and Newton's methods), the ability to formulate and apply material and energy balances in process engineering

Content:
- Recap of algebraic systems, differential equations, and their numerical solution methods
- Flowsheet simulation
- Optimization algorithms 101: real-world applications, including multi-objective approaches
- Machine-learning (ML) methods and when to use them
- Physical models, ML models, and hybrid approaches

Intended Learning Outcomes:
The lecture aims to equip students to:
- understand and compare modeling, simulation, and optimization;
- explain the basic principles of modeling;
- describe simulation techniques and algorithms needed for computer assistance in process engineering; and

- identify optimization problems and explain suitable optimization approaches.

The excercise aims to equip students to:
- describe process engineering problems and implement them in suitable software;
- apply simulation techniques tailored to specific problems;
- solve both simulation and optimization problems; and
- work in teams to solve problems and present the results.

Teaching and Learning Methods:
The module consists of lectures where methods and real-world examples are presented. In parallel, there are hand-on tutorials, in which the students (in groups) implement the methods in code.

Media:
Lecture scripts, lecture notes, usage of computer to code

Reading List:
*) Biegler et al: Systematic Methods of Chemical Process Design, Prentice Hall, 1997
*) Engeln-Müllges et al: Numerik-Algorithmen: Verfahren, Beispiele, Anwendungen, Springer Heidelberg, 2011
*) Ullmann's Modeling and Simulation, Wiley-VCH, Weinheim, 2007.
*) C. M. Bishop: Pattern Recognition and Machine Learning, Springer, 2007
*) K. P. Murphy: Machine Learning – A Probabilistic Perspective, MIT Press, 2012
*) T. Hastie, R. Tibshirani, J. Friedmann: The Elements of Statistical Learning, Springer, 2008

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

Courses (Type of course, Weekly hours per semester), Instructor:
Computer Methods for Process Engineers (Vorlesung mit integrierten Übungen, 4 SWS)
Burger J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1259: Experiment Design and Planning in Chemistry | Projektierung in der Chemie

Version of module description: Gültig ab winterterm 2016/17

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

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

Description of Examination Method:
The first part of the assessment takes the form of project work, including e.g. planning, laboratory work and a written evaluation of the project. This is to demonstrate that students can practically apply the acquired methods (e.g. literature research or pipetting) in order to design and work on small projects independently. The second part of the assessment includes a ten-minute presentation, in which the results are briefly introduced to the class and lecturers. This serves the assessment of students' communicative proficiency in discussing scientific topics in front of an audience. Project work accounts for two-thirds of the grade, the presentation makes up the remaining one-third.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge and experience of laboratory work, such as introduced in the modules WZ 1680 (LV3641) and WZ1681 (LV968 and LV981)

Content:
The module covers various methods that are required for independent project work. The lecture first outlines the content and time requirements of chemistry projects as well as the main sources of error. It covers everything from literature research to writing reports. Finally, practical methods (pipetting, weighing, preparation of solutions and dilutions) are introduced by exercises to deepen the students' theoretical knowledge and allow them to plan and perform projects independently (starting from literature research until experiments realized in a laboratory).

Intended Learning Outcomes:
At the end of the module, students are able to complete basic work (e.g. pipetting, weighing, preparation of solutions and dilutions) in the laboratory. In addition, they can develop small projects, fulfill a project plan, as well as verify and analyse the results.

Teaching and Learning Methods:
The module consists of lectures, practical tutorials and project work. The lectures deal with the theoretical background of the topic, which is required for independent project planning. Tutorials build on these lectures and help consolidating students' knowledge in practice. In addition, students choose a project in consultation with their lecturer, which they then plan and carry out independently. Finally, students prepare a written report.

Media:
Power-Point, laboratory

Reading List:
Organikum, Lehrbuch der analytischen und präparativen anorganischen Chemie (ISBN 978-3527339686) ; 1x1 der Laborpraxis (ISBN 978-3527316571)

Responsible for Module:
Corinna Urmann (corinna.urmann@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 TUM | Electives TUM

Module Description

IN2346: Introduction to Deep Learning | Introduction to Deep Learning

Version of module description: Gültig ab summerterm 2018

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 test of 90 minutes at the end of the course.
- After each practical session, the students will have to provide the written working code to the teaching assistant for evaluation. The students will be awarded a bonus in case they successfully complete all practical assignments.

The exam takes the form of a written test. Questions allow to assess acquaintance with the basic concepts and algorithms of deep learning concepts, in particular how to train neural networks. Students demonstrate the ability to design, train, and optimize neural network architectures, and how to apply the learning frameworks to real-world problems (e.g., in computer vision). An important aspect for the student is to understand the basic theory behind the training process, which is mainly coupled with optimization strategies involving backprop and SGD. Students can use networks in order to solve classification and regression tasks (partly motivated by visual data).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Programming knowledge is expected. At least one programming language should be known, preferably Python.

MA0902 Analysis for Informatics
MA0901 Linear Algebra for Informatics

Content:
- Introduction to the history of Deep Learning and its applications.

- Machine learning basics 1: linear classification, maximum likelihood
- Machine learning basics 2: logistic regression, perceptron
- Introduction to neural networks and their optimization
- Stochastic Gradient Descent (SGD) and Back-propagation
- Training Neural Networks Part 1:
regularization, activation functions, weight initialization, gradient flow, batch normalization, hyperparameter optimization
- Training Neural Networks Part 2: parameter updates, ensembles, dropout
- Convolutional Neural Networks, ConvLayers, Pooling, etc.
- Applications of CNNs: e.g., object detection (from MNIST to ImageNet), visualizing CNN (DeepDream)
- Overview and introduction to Recurrent networks and LSTMs
- Recent developments in deep learning in the community
- Overview of research and introduction to advanced deep learning lectures.

Intended Learning Outcomes:
Upon completion of this module, students will have acquired theoretical concepts behind neural networks, and in particular Convolutional Neural Networks, as well as experience on solving practical real-world problems with deep learning. They will be able to solve tasks such as digit recognition or image classification.

Teaching and Learning Methods:
The lectures will provide extensive theoretical aspects of neural networks and in particular deep learning architectures; e.g., used in the field of Computer Vision.
The practical sessions will be key, students shall get familiar with Deep Learning through hours of training and testing. They will get familiar with frameworks like PyTorch, so that by the end of the course they are capable of solving practical real-world problems with Deep Learning.

Media:
Projector, blackboard, PC

Reading List:
- Slides given during the course
- www.deeplearningbook.org

Responsible for Module:
Nießner, Matthias; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Deep Learning (IN2346) (Vorlesung mit integrierten Übungen, 4 SWS)
Nießner M [L], Chen Y, Höllein L, Lange U, Li H, Nießner M, Schmidt J, Weitz S, Yeshwanth C
For further information in this module, please click campus.tum.de or here.

Module Description

MW1141: Modelling of Cellular Systems | Modellierung zellulärer Systeme

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:
Die Prüfungsleistung wird in Form einer Klausur erbracht. Sie besteht aus Kurzfragen und Rechenaufgaben. Es wird geprüft in wieweit die Studierenden die grundlegenden Konzepte der mathematischen Modellierung und Modellanalyse bei zellulären (biologischen) Systemen verstehen und anwenden können. Es ist eine schriftliche Klausur mit einer Prüfungsdauer von 90 Minuten vorgesehen. Die Klausur wird in jedem Semester angeboten (im WS zeitnah am Beginn). Es sind keine Hilfsmittel zugelassen. Durch eine Studienleistung in Form einer Projektarbeit oder Präsentation kann die Modulnote um 0,3 verbessert werden (APSO, §6(5)).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzungen für die erfolgreiche Teilnahme sind mathematische Kenntnisse, wie sie in Bachelorstudiengängen an wissenschaftlichen Hochschulen vermittelt werden.

Content:
Das Modul soll die Grundlagen der mathematischen Modellierung, der Analyse und der Simulation von zellulären Systemen vermitteln und vertiefen. Zu den wichtigen Prozessen gehören die Enzym-katalysierten Reaktionen, die Polymerisation von Makromolekülen und die zelluläre Signalübertragung.
Wesentliche Inhalte sind:
- Graphentheoretische Analysen,
- Aufstellen von Bilanzgleichungen für konzentrierte und verteilte Systeme,
- Analyse stöchiometrischer Netzwerke,
- Thermodynamik zellulärer Prozesse,
- Reaktionskinetiken (Enzyme, Polymerisationsprozesse, Signalübertragung),

- Stochastische Systeme

Intended Learning Outcomes:
Nach der Teilnahme an diesem Modul sind die Studierenden mit den biologischen und theoretischen Grundlagen von zellulären Systemen vertraut und in der Lage, Bilanzgleichungen für komplexe zelluläre Netzwerke zu erstellen und zu analysieren. Anhand der Modelle sind die Studierenden in der Lage das Verhalten der Netzwerke durch Simulation vorherzusagen und den gesamten biotechnologischen Prozesses zu bewerten (zeitliches Verhalten, Produktausbeuten).

Teaching and Learning Methods:
In der Vorlesung werden mathematische Ableitungen und Zusammenhänge an der Tafel mit Hilfe von Powerpoint-Präsentationen aufgezeigt. Wesentliche Aspekte werden dann wiederholt aufgegriffen und in den Übungen vertieft. Die Übungen sollen zum Teil am Rechner/Laptop durchgeführt werden, um komplexere Aufgaben, wie mathematische Modellierungen und/oder Simulationen bearbeiten zu können. Die Lösungsstrategien werden dann gemeinsam mit den Studenten besprochen, um ein vertieftes Verständnis von zellulären Systemen zu entwickeln.

Media:
Die in der Vorlesung verwendeten Folien werden den Studierenden in geeigneter Form zugänglich gemacht. Übungsaufgaben werden rechtzeitig verteilt und die Musterlösungen mit den Studierenden diskutiert.

Reading List:
Zur Verfügung stehen englischsprachige Lehrbücher, die Teilaspekte des genannten Stoffes abbilden. Zu nennen sind: Nielsen, Villadsen, Lieden: Bioreaction Engieneering Principles (Kluwer Academic Press, 2003), B. O. Palsson: Systems Biology: Properties of Reconstructed Networks (Cambridge University Press, 2006), Kremling: Systems Biology (CRC Press).

Responsible for Module:
Kremling, Andreas; Prof. Dr.-Ing.

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

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

Module Description

MW1969: Desalination | Desalination [Desal]

Version of module description: Gültig ab summerterm 2013

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

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

Description of Examination Method:
The theoretical knowlegde gained in the lecture is to be practically applied in exercise lessons by means of case studies. The exercises course also includes a laboratory course in which students carry out experiments with lab-scale desalination plants.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Physics, Thermodynamics and Heat and Mass Transfer.

Content:
Potable water is one of the most valuable ressources we have on our earth. The "blue gold" is essential for any life. Potable water ressources are limited and water scarcity is a big challenge in many parts of the world already today and will become even more urgent in the future.
Water desalination is one of the main technological answers to this challenge. Today, 80 Million Cubicmeter per day of Desalination Capacity is installed worldwide, showing exponential growth. This lecture wants to provide students with both basic theoretical and practical tools to be able to cope with engineering solutions to overcome the future lack of potable water. The focus will be on the thermodynamic and chemical properties of seawater, the wide range of different desalination technologies with a major on distillation and membrane processes, renewable energy and transient power supply in desalination, large and small scale applications and finally also on desalination-driven environmental aspects.

Intended Learning Outcomes:
Having successfully passed the Desalination lecture the young engineers are able to understand, design and optimize desalination plants on their own. Furthermore they are sensitized for future technological challenges in desalination e.g. transient power supply for membrane processes.

A deep understanding of the advantages and disadvantages of different desalination priciples empower them not only to make viable decisions during plant design and construction but also to use their knowlegde to further develop existing ideas. The students are prepared for solving engineering problems about potable water issues with a strong focus on desalination.

Teaching and Learning Methods:
In the lecture, the subject matter is explained in an oral presentation. The exercises include both presentation and experimental investigations of the students themselves. The excerises put the main focus on deepening the understanding of the therotical aspects taught in the lecture. Difficulties will be explained in detail and problems of understanding will be solved. The exercises are not obligatory but highly recommended also in view of the exam.

Media:
Oral presentations, Tablet-PC support, lab-scale desalination plants (solar stills) in laboratory courses, excercises as preperation for the final exam.

Reading List:
Lecture notes and transkript incl. references.

Responsible for Module:
Wen, Dongsheng; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Tutorial Desalination (Übung, 1 SWS)
Wen D [L], Ma X (Albrecht N)

Desalination (Vorlesung, 2 SWS)
Wen D [L], Ma X (Albrecht N)
For further information in this module, please click campus.tum.de or here.

Module Description

MW2397: Basics in Computational Methods in Biotechnology | Grundlagen rechnergestützter Methoden in der Biotechnologie [Bcom]

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 75	**Contact Hours:** 45

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

Description of Examination Method:
The examination consists of three exercises. The first part is a programming problem. In the second part, comprehension questions on selected topics of the module are examined in the form of a written testate (30 min). This is to check whether the students know problems and solution strategies of the lecture content. The third part results from the evaluation of homework (during the semester, two to three assignments are given in the form of programming tasks that have to be worked on independently). The aim is to show students that they can create simple programs and functions with MATLAB and can simulate simple mathematical models. Approved tools: none.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Prerequisites for a successful participation are mathematical knowledge as taught in bachelor's programs at scientific universities.

Content:
The course teaches basics of numerical methods in biotechnology with a focus on bioprocess engineering, biotechnological and systems biology problems. Essential contents are: Introduction to use computer-aided methods - Introduction to Matlab - Data representation and processing - Fundamentals of numerical solution methods - Case studies

Intended Learning Outcomes:
After attending the module, the students will be able to create and simulate simple programs and functions using MATLAB. Furthermore, they are familiar with problems and solution strategies in the numerical integration of differential equations.

Teaching and Learning Methods:
The topics of the module are taught theoretically in the lecture with blackboard notation and PowerPoint presentations. Essential aspects are taken up repeatedly. The slides used in the lecture will be made available to the students in a timely manner. They will be introduced to the workings and applicability of MATLAB and will be able to deepen their understanding of problem definitions and solution strategies in the numerical integration of differential equations. Exercises are distributed and the model solution is discussed with the students. The homework will be presented in detail and open questions will be discussed. As a result, students independently learn how to create and simulate programs and functions using MATLAB.

Media:
PowerPoint, blackboard, script, and exercises

Reading List:
Literature: Mathematik mit MATLAB (v. H. Blenker, Springer Verlag, 2000), Numerische Mathematik für Ingenieure und Naturwissenschaftler (v. F. Weller, Vieweg Verlag, 1996)

Responsible for Module:
Kremling, Andreas; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen rechnergestützter Methoden in der Biotechnologie (Vorlesung, 3 SWS)
Kremling A [L], Beyer M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1174: Molecular Biology of Biotechnologically Relevant Fungi | Molecular Biology of Biotechnologically Relevant Fungi

Version of module description: Gültig ab summerterm 2025

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 takes the form of a written exam (60 minutes) and a presentation (60 minutes; pass/fail credit requirement).
Regular, active participation in the courses is expected. A written exam (60 min, graded) serves to test the theoretical skills learned in lectures and seminars. In the written exam, the students show whether they are able to structure the knowledge they have acquired and present the essential aspects of the topics discussed. In addition, they should also show that they are able to combine the interrelationships of the molecular biology of fungi in a meaningful way and transfer them to similar topics (e.g. a current but not discussed topic of fungal biotechnology). The presentation (in English) with subsequent discussion is designed to teach independent scientific research and to demonstrate the ability to present complicated scientific relationships in a structured and logical way. The module grade is determined by the grade of the written examination. The module is passed if a grade better than 4.1 is achieved and the course work (lecture) is successfully completed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
For better understanding, basic knowledge of microbiology is advantageous.

Content:
The course is to teach basic knowledge about the diversity and physiology of fungi, and in addition covers more in-depth information on fungal biotechnological applicabilities. A focus will be the unique capability of fungi to degrade and convert plant biomass. Exemplary contents that will be discussed are: gene technology (bio-engineering), plant cell walls as substrate and their

degradation, signaling pathways of substrate perception, biotechnological applications of enzyme and small-molecule production, as well as application of fungi in the agricultural industry.
In the practical/seminar part of the course, selected topics will be discussed in more detail by student presentations and with the help of practical examples. In addition, an excursion to the Clariant Sunliquid demonstration plant in Straubing is planned, where bioethanol is being produced from fungal conversion of biomass.

Intended Learning Outcomes:
After successful participation in the module, the students will have advanced knowledge of the biotechnological applications of fungi for the production and development of natural and artificial biocompounds.
They will be able to:
• recapitulate the fungal metabolic capabilities
• comprehend and name the fundamental signaling pathways for metabolic adaptation
• using selected examples, classify the respective enzyme systems and their functions in anabolic/catabolic reactions
• understand the molecular techniques for genome manipulation and strain development and discuss them
• critically assess the pros and cons of the presented production systems.
Moreover, the module is intended to help develop problem-solving skills as well as to foster the interest for eukaryotic microbiology, it's advantages and disadvantages, and the importance particularly of filamentous fungi for environment and industry.

Teaching and Learning Methods:
Teaching technique: Lecture - teaching method: presentation; development of general concepts on the chalkboard
In the demonstration: teaching method: talk, demonstration; learning activity: research of relevant literature, prepare and give a talk, contructive discussion of the contents

Media:
PowerPoint presentation; chalkboard work; original research papers; lab demonstrations

Reading List:
Unfortunately no text book is available that covers all the contents of the course, but the following sources are good for basics and as additional reading:
- Money, Nick, 2007, “Triumph of the Fungi: A Rotten History”, Oxford Univ. Press
- Hudler, G.W., 1998, “Magical mushrooms, mischievous molds”, Princeton University Press
- Kendrick, Bryce, 2000, “The Fifth Kingdom”, 3rd ed., Focus Pub/R Pullins Co
- Kavanagh, Kevin, 2011, „Fungi – Biology and Applications”, Wiley-VCH
- Arora, D.K., 2004, “Fungal Biotechnology in Agricultural, Food, and Environmental Applications – Mycology Series; Vol. 21”, Marcel Dekker, Inc.
- Kück, U. et al., 2009, “Schimmelpilze – Lebensweise, Nutzen, Schaden, Bekämpfung“, Springer
- Kubicek, C.P., 2013, “Fungi and Lignocellulosic Biomass“, Wiley-Blackwell

Responsible for Module:
Benz, Johan Philipp; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Biologie biotechnologisch relevanter Pilze (Vorlesung mit integrierten Übungen, 4 SWS)
Benz J [L], Benz J, Tamayo Martinez E
For further information in this module, please click campus.tum.de or here.

Research Internship (max. 20 ECTS) | Research Internship (max. 20 ECTS)

Module Description

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

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
no

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

presentations. Project works can also be done in cooperation with external institutions, e.g. companies.

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

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

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

Reading List:
Technical literature

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

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

Research Internship Master Chemical Biotechnology (Costa) (Forschungspraktikum, 15 SWS)
Costa Riquelme R [L], Atoini Y, Banda Vazquez J, Costa Riquelme R, Gutierrez Armayor D, Lipinski S

Research Internship Master Students 15 ECTS (Forschungspraktikum, 15 SWS)
Fang W [L], Fang W, Fortuna dos Santos Miranda C

Research Internship Master Chemical Biotechnology CS0014 (Forschungspraktikum, 15 SWS)
Ledendecker M [L], Ledendecker M

Forschungspraktikum Master CBT (Niederholtmeyer) (Forschungspraktikum, 15 SWS)
Niederholtmeyer H [L], Banlaki I, Crean E, Gaizauskaite A, Kalkowski J, Li Y, Niederholtmeyer H, Osmanova G, Sharma B

Research Internship Master Chemical Biotechnology (Sieber) (Praktikum, 15 SWS)

Sieber V [L], Al-Shameri A, Arana Pena S, Fuchs A, Giustino A, Grundheber J, Hofer N, Kinateder T, Köllen T, Lehmann V, Liu Y, Malubhoy Z, Marosevic M, Matena F, Mayer M, Ostertag T, Raga Carbajal E, Rau M, Romeis D, Rühmann B, Scheerer J, Schieder D, Sieber V, Skopp A, Tong L

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

Module Description

CS0294: Research Internship Master 5 ECTS | Research Internship Master 5 ECTS

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 30	**Contact Hours:** 120

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

Description of Examination Method:
The examination consists of a graded internship report (15-30 pages, depending on the topic) and/or an Presentaion (20-30 minutes, depending on the topic) on the contents and contents of the internship results containing at least an overview of the state of knowledge on the project topic as well as the presentation of the working methods used and a presentation of the results with interpretation. In an overall grade, the quality of the familiarisation with the topic, the experimental work, the interpretation of the results and the written elaboration and/or presentation are evaluated.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Background knowledge of the respective focus to which the project topics of the research internships are assigned. In this case, having a background in Python or SuperPro Designer and experience in the laboratory is often recommended.

Content:
Research-related work at the chairs and working groups of the TUM Campus Straubing. The students receive tasks from the research area of the supervising examiner, which they work on under guidance in the form of projects. The subject areas must be able to be assigned to the technical content of the study program. The students plan the project work largely independently under the guidance of the supervisors. The project work consists of 120 working hours, fixed in consultation with the supervisors, usually as a block internship on consecutive weeks, which can be deviated from in consultation. The project work is documented and evaluated in the form of an internship report. In addition, a supplementary presentation of the work progress takes place. The project work can also be done with external institutions, such as companies.

Intended Learning Outcomes:
After participation in the module, students understand the principles of approach to (research)projects in addition to the subject-specific knowledge and working methods taught in the research internship projects, the planning of project work and the critical evaluation of the project results and can apply them to new project tasks. Furthermore, they are able to document, interpret and summarise project work and results in written form.

Teaching and Learning Methods:
Depending on the focus and topic, for example, experiments in laboratories, guided or independent literature and data research, concept studies, simulations, methods for project and experimental design or test evaluation

Media:
Depending on the focus and topic, e.g., experimental equipment (laboratory), databases, libraries, specialized software, programming software, simulation software, project and experimental design software

Reading List:
technical literature;
Davies, M. B. (2007): Doing a successful research project. Using qualitative or quantitative methods. Basingstoke: Palgrave

Responsible for Module:
Zollfrank, Cordt; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Kleines Forschungspraktikum Master CBT (Niederholtmeyer) (Forschungspraktikum, 4 SWS)
Banlaki I, Crean E, Gaizauskaite A, Kalkowski J, Li Y, Niederholtmeyer H, Osmanova G, Sharma B

Research Internship Master 5 ECTS (Praktikum, 5 SWS)
Blombach B, Glawischnig E, Hädrich M, Vital S

Research Internship Master 5 ECTS (Forschungspraktikum, 5 SWS)
Costa Riquelme R [L], Costa Riquelme R

Reseach Internship Master 5 ECTS (RES) (Praktikum, 5 SWS)
Gaderer M [L], Huber B, Putra L

Research Internship Master 5 ECTS (Forschungspraktikum, 5 SWS)
Sieber V [L], Al-Shameri A, Arana Pena S, Fuchs A, Giustino A, Grundheber J, Hofer N, Kinateder T, Köllen T, Lehmann V, Liu Y, Malubhoy Z, Marosevic M, Matena F, Mayer M, Ostertag T, Raga Carbajal E, Rau M, Romeis D, Rühmann B, Scheerer J, Schieder D, Sieber V, Skopp A, Tong L

Research Internship Master 5 ECTS (Forschungspraktikum, 5 SWS)

Zavrel M [L], Beerhalter D, Bogran Linares G, Borger J, Dsouza V, Geisler N, Grundwürmer M, Kariuki E, Marino Jara J, Stegemeyer U, van der Walt H, Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0297: Research Internship Master 10 ECTS | Research Internship Master 10 ECTS

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

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

Description of Examination Method:
The examination consists of a graded internship report (15-30 pages, depending on the topic) and/or an Presentaion (20-30 minutes, depending on the topic) on the contents and contents of the internship results containing at least an overview of the state of knowledge on the project topic as well as the presentation of the working methods used and a presentation of the results with interpretation. In an overall grade, the quality of the familiarisation with the topic, the experimental work, the interpretation of the results and the written elaboration and/or presentation are evaluated.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Background knowledge of the respective focus to which the project topics of the research internships are assigned. In this case, having a background in Python or SuperPro Designer and experience in the laboratory is often recommended.

Content:
Research-related work at the chairs and working groups of the TUM Campus Straubing. The students receive tasks from the research area of the supervising examiner, which they work on under guidance in the form of projects. The subject areas must be able to be assigned to the technical content of the study program. The students plan the project work largely independently under the guidance of the supervisors. The project work consists of 240 working hours, fixed in consultation with the supervisors, usually as a block internship on consecutive weeks, which can be deviated from in consultation. The project work is documented and evaluated in the form of an internship report. In addition, a supplementary presentation of the work progress takes place. The project work can also be done with external institutions, such as companies.

Intended Learning Outcomes:
After participation in the module, students understand the principles of approach to (research)projects in addition to the subject-specific knowledge and working methods taught in the research internship projects, the planning of project work and the critical evaluation of the project results and can apply them to new project tasks. Furthermore, they are able to document, interpret and summarise project work and results in written form.

Teaching and Learning Methods:
Depending on the focus and topic, for example, experiments in laboratories, guided or independent literature and data research, concept studies, simulations, methods for project and experimental design or test evaluation

Media:
Depending on the focus and topic, e.g., experimental equipment (laboratory), databases, libraries, specialized software, programming software, simulation software, project and experimental design software

Reading List:
technical literature;
Davies, M. B. (2007): Doing a successful research project. Using qualitative or quantitative methods. Basingstoke: Palgrave

Responsible for Module:
Zollfrank, Cordt; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Internship Master 10 ECTS (Forschungspraktikum, 10 SWS)
Banlaki I, Crean E, Gaizauskaite A, Kalkowski J, Li Y, Niederholtmeyer H, Osmanova G, Sharma B

Research Internship Master 10 ECTS (Forschungspraktikum, 10 SWS)
Fang W [L], Fang W, Fortuna dos Santos Miranda C

Research Internship Master 10 ECTS (RES) (Praktikum, 10 SWS)
Gaderer M [L], Huber B, Putra L

Research Internship Master 10 ECTS (Sieber) (Forschungspraktikum, 10 SWS)
Sieber V [L], Al-Shameri A, Arana Pena S, Fuchs A, Giustino A, Grundheber J, Hofer N, Kinateder T, Köllen T, Lehmann V, Liu Y, Malubhoy Z, Marosevic M, Matena F, Mayer M, Ostertag T, Raga Carbajal E, Rau M, Romeis D, Rühmann B, Scheerer J, Schieder D, Sieber V, Skopp A, Tong L

Research Internship Master 10 ECTS (Praktikum, 10 SWS)
Zavrel M [L], Beerhalter D, Bogran Linares G, Borger J, Dsouza V, Geisler N, Grundwürmer M, Kariuki E, Marino Jara J, Stegemeyer U, van der Walt H, Zavrel M
For further information in this module, please click campus.tum.de or here.

Interdisciplinary Electives | Allgemeinbildende/Fachübergreifende Wahlmodule

Module Description

CH0136: Principles of Patent Law | Grundlagen des Patentrechts

Version of module description: Gültig ab summerterm 2025

Module Level: Bachelor/Master	**Language:** German	**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:
Die Prüfungsleistung wird in Form einer 90-minütigen schriftlichen Klausur erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit eine Fragestellung des Patentrechts richtig erkannt wird und Wege zu einer Lösung gefunden werden können. Beispielsweise können dies Fragen zum Ablauf einer korrekten Patentanmeldung oder die Bewertung von Erfindungen in patentrechtlichen Prüfungsverfahren sein. Die Antworten erfordern gegebenenfalls eigene Formulierungen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Keine fachlichen Voraussetzungen notwendig. Gute Deutschkenntnisse erforderlich. Englischkenntnisse sind nicht erforderlich, aber hilfreich.

Content:
Einführung in den gewerblichen Rechtsschutz und insbesondere das EPÜ-Patentsystem (Europäisches Patent). Das Modul vermittelt Grundkenntnisse im Hinblick auf Anmeldeerfordernisse, Patentierungsvoraussetzungen, Priorität, Prüfungsverfahren, Einspruch, Beschwerde, Durchsetzung und Wirkungen von Patenten.

Intended Learning Outcomes:
Nach der Teilnahme am Modul "Grundlagen des Patentrechts" kennen die Studierenden die Abläufe im Patentsystem des EPÜ. Sie sind in der Lage, die patentrechtlichen Aspekte von Erfindungen zu bewerten und wissen, wie die patentrechtlich richtige Vorgehensweise bei der

Anmeldung von Patenten ist. Sie sind in der Lage, die Verletzung eines Patents zu erkennen, und kennen die Grundlagen der Durchsetzung von Patenten gegenüber Patentverletzern.

Teaching and Learning Methods:
Die Inhalte des Moduls werden in einer Vorlesung (2 SWS) durch Vortrag und Präsentation vermittelt. Ferner werden gemeinsam konkrete Fragestellungen beantwortet und ausgesuchte Beispiele bearbeitet, wodurch die Studierenden zur inhaltlichen Auseinandersetzung mit den Themen angeregt werden.

Media:
Präsentationen, Skript, Übungsaufgaben

Reading List:
-EPÜ und PatG in Auszügen
-Skript
-Broschüre "Leitfaden zum Europäischen Patent" des Europäischen Patentamts

Responsible for Module:
School of Natural Sciences, Department Chemie

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen des Patentrechts (CH0136) (Vorlesung, 2 SWS)
Parchmann S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0258: Talking Green: Communication and Renewable Resources in Society | Talking Green: Communication and Renewable Resources in Society

Version of module description: Gültig ab winterterm 2025/26

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:
Over the course of the semester, students are expected to prepare presentations, participate in role plays and work on cases in groups with video analyses (ungraded). The graded examination is completed in two parts. The first part is a graded course (presentation: 20 minutes) in grammar schools and other secondary schools, in which the acquired didactic skills are to be applied (80 % of the grade). The second part of the examination consists of a written report (approx. 10 pages) on the course held at the grammar school (20 % of the grade).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The basics of communication and didactics, communication methodology, communication rules and their application in everyday working life as well as goal-orientated dialogue management are taught. In addition, expression and language, presentation of the course, presentation of the contents and their practical teaching, the organisation of teaching units at the schools involved, the characterisation of teaching requirements and public relations issues are covered.

Intended Learning Outcomes:
After completing the module, students will be able to analyse basic counselling and communication models and assign the underlying theory to the models accordingly.
Furthermore, students will be able to apply counselling and communication models using case studies.

In addition, they can review their own basic attitude and reflect on their own counselling and communication behaviour. Students can formulate and define learning objectives appropriate to the respective target group and the content to be taught.
They can organise a teaching unit in a meaningful sequence according to the learning objectives and can select appropriate teaching methods to suit the objectives. They can design and implement a curriculum for their teaching unit. Furthermore, students will be able to explain their content-related topics in a binding manner and relate them to the fields of work of the TUM Campus Straubing, analyse the content-related needs of the school and plan the scope of teaching, and will be able to coordinate press and public relations work with content and intentions from the field of renewable resources.

Teaching and Learning Methods:
In addition to the lecture, exercises, role plays, case studies, excursions and video analyses of individual and group presentations will be carried out. There will also be a teaching rehearsal in front of a class at a grammar school in the region.

Media:
Presentations, script, videos, exercise sheets, flipchart, Powerpoint, illustrative objects (renewable raw materials), case descriptions, blackboard

Reading List:
Philipps, E. & Robles, R. (2023). Foundations of Educational Technology: Learning and Instructional Design, Vol 1. Middlesex: Kruger Brentt Publisher.
Philipps, E. & Robles, R. (2024). Foundations of Educational Technology: Learning and Instructional Design, Vol 2. Middlesex: Kruger Brentt Publisher.
McDonald, J.K. & West, R. (2021). Design for Learning: Principles, Processes, & Praxis. Provo: Brigham Young University.
Littlejohn, S.W., Foss, K.A. & Oetzel, J.G. (2021). Theories of Human Communication. Longrove: Waveland Press.
McQuail, D. & Deuze, M. (2020). Media and Mass Communication Theory. London: SAGE Publications Ltd.
Griffin, E., Ledbetter, A. & Sparks, G. (2022). A First Look at Communication Theory. London: McGraw-Hill Education.

Responsible for Module:
Claudia Martin

Courses (Type of course, Weekly hours per semester), Instructor:
Talking Green: Communication and Renewable Resources in Society (Vorlesung mit integrierten Übungen, 4 SWS)
Martin C [L], Martin C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0298: Applied Ethics for Renewable Resources | Applied Ethics for Renewable Resources

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
In a written examination (60 minutes), students relate on fundamental approaches to bioethics. Social issues will translate into students' tasks. Students thereby demonstrate the connections between risks and injustice. Drawing on special scenarios, students will identify areas of conflict and propose possible solutions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Definition of ethics terminology, main schools of thought in approaches to bioethics such as Kantian ethics / deontological ethics
Utilitarianism (theory of consequentialism), liberal individualism (rights-based theory), communitarianism (community-based theory); how bioethical issues are perceived in society, such as
-red gene technology
-green gene technology
-Areas of conflict based on the use of renewable resources: "food before fuel" slogan, exploitation of agricultural land for chemical products or for re-use as energy in light of the world's hunger epidemic. This module will also discuss food waste along the value chain from field to fork.
Legislation laid down in the Convention on Biomedicine (Council of Europe); selected areas of contention such as bioethics for all living creatures; human bioethics; definition of life; definition of death; medical ethics; research; exploitation of resources (production); resource waste (efficiency)

Intended Learning Outcomes:
After completion of the module, students will understand the fundamentals of bioethics. They will be able to gather information on the main schools of thought in approaches to bioethics. Students will have formed their own opinions on aspects of the social issues covered. They will be able to identify issues arising from the production of renewable resources and propose possible solutions using methods learnt in class.

Teaching and Learning Methods:
Lectures teach basic knowledge, presentations, tutorials on practical approches in bioethics, expert lectures on selected topics related to the ethical evaluation of using renewable resources

Media:
script, PowerPoint presentation, documentaries, group work

Reading List:
"Günter Altner: Naturvergessenheit. Grundlagen einer umfassenden Bioethik. WBG, Darmstadt 1991 ISBN 3534800435;
Suhrkamp Taschenbuch Wissenschaft Nr. 1597: Bioethik - Eine Einführung Taschenbuch – 2003 von Marcus Düwell (Herausgeber, Vorwort), Klaus Steigleder (Herausgeber, Vorwort)
European Union, 2014, Health and Consumers. Food. Stop Food Waste. European Commission. Http://ec.europa.eu/food/food/sustainability/index-en.htm [acessed June 6, 2014]
Agrarethik: Landwirtschaft mit Zukunft Gebundene Ausgabe – Juli 2012
von Uwe Meier (Herausgeber)
Energie aus Biomasse - ein ethisches Diskussionsmodell - Michael Zichy, Christian Duernberger, Beate Formowitz, Anne Uhl, Maendy Fritz, Edgar Remmele, Stephan Schleissing, Bernhard Widmann (2011): ""Energie aus Biomasse - ein ethisches Diskussionsmodell"". Darmstadt, Vieweg +Teubner, ISBN: 978-3-8348-1733-4"

Responsible for Module:
Andrea Potzler

Courses (Type of course, Weekly hours per semester), Instructor:
Applied Ethics for Renewable Resources (Exercise) (Übung, 1 SWS)
Potzler A

Applied Ethics for Renewable Resources (Lecture) (Vorlesung, 1 SWS)
Potzler A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0324: BioTech Ventures | BioTech Ventures [Biotech Ventures]

Biotech Ventures

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
This module's learning objectives are examined via exercises comprising the three elements outlined below. The grading will reflect both group performance and individual contributions, ensuring that each student is evaluated based on their collective and personal input.
(1) Individual written reflection paper of 1/2 page (font size 12; double line spacing) (10%): At the end of each session, you will submit a reflection paper highlighting the key learnings of the course and explaining why, how, and where they might influence your project. The individual reflection will show that you can process, synthesize, and prioritize the newly learned knowledge and critically think about and argue for more expansive fields of application beyond those discussed in class.

(2) Group presentations (60%): During the class, there will be three presentations: (1) A pitch in the first weeks of the course (2 minutes), (2) a midterm pitch (10 minutes), and (3) a final pitch (15 minutes). Each pitch shows the progression of your group's biotech venture, reflecting how you incorporated the content elements of the course. In the session, you will present a part of your group's biotech venture. The final group presentation will showcase that you are able to synthesize and present your findings in a comprehensive, precise, and structured way. It will also show that you communicate clearly and perform professionally on stage and within your team. The final pitch will be graded, while the first and intermediate pitches are designed as opportunities for practice, reflection, and feedback. These preliminary presentations provide a chance to refine ideas, incorporate constructive criticism, and enhance the overall approach in preparation for the final assessment.

(3) Group written reporting of approx. 10 pages (depending on group work and size; font size 12; double line spacing) (30%): As part of a group composed in the first two weeks of the course, you will work on a biotech venture project by assessing, analyzing and designing biotech venture related strategies and actions. This assessment will show that you can directly apply the learned

frameworks, theories, and concepts to uncover and assess the implications of biotech ventures, determine and evaluate suitable ventures strategies, prioritize and initiate actions and decisions for their implementation, identify predictors of failure, and propose mitigative steps. It also illustrates that you can collaborate in a team, adopt a leader's perspective, strategize, and solve problems in an analytical and structured way. The reporting includes the submission of a weekly (1) agenda for office hours meetings, a weekly update of an (2) interview tracking spreadsheet, and (3) the pitch decks of your presentations. An assessment sheet filled in by each group member and handed in at the end of the course will clarify your individual contribution.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
To ensure a well-rounded approach, the course values participants from both social and natural sciences, recognizing that addressing complex challenges requires expertise from both domains. Given the course's emphasis on interdisciplinarity, it seeks two distinct skill sets. You should (1) have a solid foundational understanding in the subject area of entrepreneurship, bioeconomy, policy and regulatory frameworks and/or the core principles of sustainable management or you should (2) have a solid technological understanding of biotechnology, natural sciences and/or engineering sciences, demonstrated through prior coursework, practical experience, and/or a strong academic or professional interest. Students from interdisciplinary backgrounds are encouraged to apply, as well as those with a strong foundation in any one of these fields and interest to work in interdisciplinary teams, to foster diverse perspectives and collaboration within the course.

Content:
Building biotech ventures that have impact can be a very complex and demanding challenge. Often this requires an expanded skillset of how to identify, assess, analyze, design, build, and launch ventures, as well as high team effort, and very strong leadership. In addition, dynamic markets, technological uncertainties and grand challenges create additional pressures on novel ventures understanding their impact. This module provides a holistic view of the biotech venture process in a real-world project. It introduces you to theories, concepts, and frameworks for biotech ventures. Students will work on a real-world, biotech-related problem and new technology to address that problem, resulting in a venture ideation. Students will gain hands-on experience in the startup process, learning how to identify, assess, analyze, design, build, and launch ventures.

Emphasis will be placed on effective collaboration within interdisciplinary teams to tackle real-world challenges. The course will help students build a strong biotech network and community, providing opportunities for collaboration and support. Students will work on creating new companies aimed at addressing high-impact problems, from ideation to market entry. In doing so, the teams continously ensure that positive pro-social and environmental impact is created by involving and engaging experts and potential customers through interviews. This also contributes to creating a network in this sector.

Exploration of breakthrough technologies and their potential applications in solving global climate issues will be a key component of the course. Students will understand the fundamentals of economic and technical evaluations. The course will teach customer-centric approaches to developing climate solutions, emphasizing the importance of understanding and addressing customer needs. Students will have the opportunity to translate the theoretical knowledge immediately into practice through testing and evaluating their venture idea in close relation with expert and customer feedback.

Navigating the regulatory and market landscapes influencing biotech ventures will also be covered, helping students understand the broader context of their projects.

Intended Learning Outcomes:
Upon successful completion of this module, you will be able to:
Course Learning Goals:
1. Analyze relevant scientific, technical, business, and social drivers and barriers behind the complex biotech challenges and design a solution as a team to address it.
2. Synthesize insights from research, analysis, and external engagements to compose a compelling value proposition around a new venture.
3. Evaluate and iterate through the potential success of a venture plan that meets the criteria of high impact, white space, unique value proposition, and self-sustainability.
Knowledge objectives:
(1) Explain and apply key concepts, frameworks, and theories related to biotech ventures in practice
(2) Uncover and assess the implications relevant scientific, technical, business, political, and environmental drivers and barriers behind biotech ventures
(3) Determine and evaluate venture strategies considering venture-specific and contextual factors through research and external feedback
(4) Prioritize and initiate actions and decisions for implementing biotech ventures with impact (e.g., through circularity considerations)
(5) Identify predictors of failure and propose mitigative steps

Competencies objectives:
(1) Improve analytical, structured problem-solving, synthesis, and prioritization competencies
(2) Enhance team collaboration and leadership competencies
(3) Strengthen communication, presentation, and argumentation skills
(4) Build up critical thinking and strategizing competencies
(5) Perform under a maximised degree of realism in building a venture
(6) Work in an interdisciplinary team with members of different academic and disciplinary backgrounds.

Teaching and Learning Methods:
The module consists of an introductory session in which the fundamentals of biotech ventures will be shared and discussed. In addition, groups will be assembled, and each group will work on a real-world venture for which a business case will be jointly developed throughout the course.

To enable building up a solid knowledge fundament, action-learning elements such as presentations and discussions of course material, interview results, and relevant publications; individual mentoring; and interactions with guest speakers are integrated.

Continuous mentoring on the biotech ventures will ensure that the newly acquired knowledge will be directly applied. Groups are asked to gather information on their venture cases through interviews.

Through presentations, discussions of intermediate findings, guest lectures, and feedback provided by the instructor(s), mentors, and industry experts, you will be able to share and get an assessment of your progress continuously. The module will end with a group presentation followed by a moderated Q&A and joint reflection exercise.

Media:
Presentations, flipchart, whiteboard, digital tools, videos, Zoom (for feedback sessions)

Reading List:
Class materials, lecture slides, suggested readings, other materials recommended for each team and guest speaker slides will be posted on Moodle.

Responsible for Module:
Claudia Doblinger

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

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

PiM2025: Plug-in Modules | Plug-in-Module

Module Description

MGT001410: ChangeMakers: Entrepreneurial and Design Competencies for Societal Transformation | ChangeMakers: Entrepreneurial and Design Competencies for Societal Transformation

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
This module's learning objectives are examined via exercises (“Übungsleistung”) comprising the three elements outlined below. There is no written exam.

(1) Group final presentation (50%): In the final session, you will present your team's approach and solution for a societally relevant challenge identified at the beginning of the course. The presentation format can be chosen by your team and should include the presentation of a design artifact. Design artifacts can include a 3-dimensional object, a visual representation, a video, a storyline, a systems map, and many other forms of storytelling and visualization. Presentations will last approximately 5 minutes, followed by a 5-10 minute Q&A and feedback round. Each team member must actively participate so your individual contribution is identifiable and appraisable. The final group presentation will showcase that you have acquired and can demonstrate essential entrepreneurial and design competencies: focus – you can identify whether a problem is worth solving; courage – you understand your role in creating change; imagination – you are capable of developing and articulating a vision; and action – you know how to take next steps.

(2) Individually written reflection paper (20%): At the end of the course, you will submit a short paper (2 pages excl. sources) reflecting on
(a) your overall experience with and synthesis of the course's format (considering both the experiential learning immersion and the reading package)
(b) your critical reflection on the design solution you and your team created
(c) whether and how the course allows and will allow you to generate hope in the face of critical societal challenges

(3) Daily course exercises (30%)
In each session during the project week, you will be asked to submit a small reflection exercise related to the day's content and learning objectives via Moodle. We will dedicate 10-15 minutes of each session to this exercise using a set of questions. You will be guided through the exercise by the course instructors. This will demonstrate that you have engaged with, understood, and critically reflected on the day's topic.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fluency in English; interest in entrepreneurship, design, and a sustainable future; willingness to work in a team;

Due to the nature of the assessments and the ongoing team-based work in this course, consistent participation is mandatory. If you need to miss a session for health reasons or other valid circumstances, please inform us in advance via email. We may provide an opportunity to make up the missed material or, in cases of documented illness, assign a "Q" grade (indicating a missed exam with an accepted medical certificate).

Please note: Conflicts such as overlapping courses or work commitments are considered planning issues and should be resolved before enrolling in the course.

Content:
In this module, students will acquire entrepreneurial and design competencies through experiential and scenario-based learning: Set in a future scenario, students will be confronted with signals (based on scientific projections) that make clear what circumstances we may live in in the future. The Impulse Symposium ahead of the project week will provide inspiration and insight to stimulate students' imagination of the future we might live in. During the immersive project week, participants will work in small teams to create a real-life practical solution for a larger societal problem: The first day of the project week creates space to explore what challenges students find relevant and care about, and to explore through design and entrepreneurial methods whether these challenges appear to be worth solving. Throughout the week, students will learn and apply creative problem-solving methods, entrepreneurial thinking and decision-making to work through that challenge they chose. Students will be encouraged to leverage Generative AI tools to illustrate the ideas they create. Students will be guided to apply visualization and prototyping methods as well as reflection techniques that will support them in producing a shareable vision of a livable and lovable future and identify why and how they can contribute to realizing it.
The module is intentionally structured to include an impulse before, as well as iteration and reflection after an immersive project week. In addition, students will receive a reading package. Combining these elements will allow students to start well-prepared, reactive their prior knowledge, inform themselves about relevant methods, and process and appraise new information.

Intended Learning Outcomes:
After successful completion of this module, students will be able to:

● Understand and apply basic entrepreneurial and design competencies, including: Focus for sophisticated problem identification; Courage to take an active role in creating change; Imagination to develop and articulate ideas; Action to take an idea forward towards implementation
● Leverage these competencies to retain hope in the face of critical societal challenges

While developing and articulating solutions in interdisciplinary project teams, students will learn how to plan, manage and conduct a project, mobilize scarce resources, act in the face of uncertainty, collaborate in a team, and present, discuss, and reflect upon their own solutions convincingly. In addition, working with future scenarios will strengthen students' creative confidence and analytical and strategic skills.

Teaching and Learning Methods:
This module relies on six core elements:

● Impulse – a university-wide public mini-symposium that includes high-quality inspirational speakers who will set the tone and give context.
● Project Week – an immersive one-week project-based experience including theory-driven and methodological impulses, team activities, interactive discussions, flipped classroom elements, and guided project work inside and outside the classroom.
● Iteration – a review of the work that has been created during the project week in small teams accompanied by feedback and support from peers and subsequent further development.
● Presentation – a celebratory moment where participating teams share their work with each other and discuss their process and results.
● Reflection – a moment to reflect on the experience and, importantly, plan for possible next steps of integrating the newly acquired skills into one’s work.
● Reading package - a collection of supporting course material, links, and articles to strengthen the understanding and sensemaking of the applied methods.

Media:
Presentations, videos, flipchart, whiteboard, digital tools, Zoom for feedback sessions, prototyping materials

Reading List:
Each semester students will be provided with a reading list relevant to the course.
Inspirational readings include (students will be asked to engage with a selection of inspirational readings):
*Arend, R. J. (2020). The roles of thought and affect on entrepreneurship – A new hope. Journal of Business Venturing Insights, 14. DOI: 10.1016/j.jbvi.2020.e00188.
* Brown, T., Carey, S.,& Wyatt, J.(2021). The next chapter in design for social innovation. Stanford Social Innovation Review.

* Giudice, M., & Ireland, C. (2023). Changemakers: How leaders can design change in an insanely complex world. Two Waves Books.
* Hari, J. (2023). Stolen focus: Why you can't pay attention--and how to think deeply again. Crown.
* Holiday, R. (2021). Courage is calling: Fortune favors the brave. Penguin.
* Hoppe, M., & Namdar, K. (2023). Towards entrepreneurship for a cause: educating transformative entrepreneurial selves for a better world. Entrepreneurship Education and Pedagogy, 6(4), 590-607.
*. Lans, T., Blok, V., & Wesselink, R. (2014). Learning apart and together: towards an integrated competence framework for sustainable entrepreneurship in higher education. Journal of Cleaner Production, 62, 37-47.
* Markovitz, D. (2020). How to avoid rushing to solutions when problem-solving. Harvard Business Review Digital Articles, 2–6.
* Mauch, C. (2019). Slow hope: Rethinking ecologies of crisis and fear. RCC Perspectives: Transformations in Environment and Society, 1. doi.org/10.5282/rcc/8556.
* Noel, L. A. (2023). Design social change: Take action, work toward equity, and challenge the status quo. Ten Speed Press.
* Thackara, J. (2005): In the Bubble: Designing in a complex world; The MIT Press.
* Wedell-Wedellsborg, T. (2017). Are you solving the right problems? Harvard Business Review, 95(1), 76–83.
* Weiss, L. (2017). Stop mindlessly going through your work day. Harvard Business Review Digital Articles, 2–4.

Responsible for Module:
Tryba, Anne; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
ChangeMakers: Entrepreneurial and Design Competencies for Societal Transformation (MGT001410, englisch) (Seminar, 4 SWS)
Tryba A, Diefenthaler A, Löhe T, Mayer C
For further information in this module, please click campus.tum.de or here.

Module Description

MCTS0051: Core Topic: Gender & Diversity | Core Topic: Gender & Diversity

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 120	**Contact Hours:** 30

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

Description of Examination Method:
Students are required to write a research paper (2000-3000 words) in which they demonstrate
- their knowledge on gender and diversity as topoi in highly technologized societies
- their ability to understand and categorize key concepts and sources stemming from gender studies and STS
- their ability to discuss issues of gender and diversity in scientific and technological contexts

Furthermore, students are required to give a presentation (15-20 minutes) in which they demonstrate that they are able to present their ideas to an audience in a clear and concise manner and react to questions and feedback from both the lecturer and their peers.

Grading: The presentation counts for 30%, the essay for 70% of the final grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The module introduces students to the following topics
- sociological, historical and philosophical perspectives on gender and diversity politics of technoscience
- gendering of technologies
- embeddedness of gender in institutions of technoscience

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

- describe and discuss the interrelation of gender, diversity, science and technology
- understand and categorize key concepts and sources stemming from gender studies and STS
- discuss ways of dealing with difference and inequality in technological societies
- use these abilities to formulate research questions on these issues

Teaching and Learning Methods:
Students are expected to read and critically engage with introductory readings in order to understand and categorize key concepts and sources stemming from gender studies and STS. By discussing these texts and working on case studies they learn to analyze and discuss ways of dealing with difference and inequality in technological societies. Presenting and discussing their findings trains students to structure their arguments and to defend them in academic debate.

Media:
Texts, slide presentations, flipchart/whiteboard, worksheets, Moodle

Reading List:
Wajcman, Judy (2010): "Feminist theories of technology", in Cambridge Journal of Economics, Vol. 34, No.1., pp.143-152;

Plus additional literature specified at the beginning of the course

Responsible for Module:
Sultan, Aysel; Dr. phil.

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

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

Module Description

MGT001485: Value Creation with AI at Scale: Strategy, Tech, People and Governance | Value Creation with AI at Scale: Strategy, Tech, People and Governance

Version of module description: Gültig ab winterterm 2025/26

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

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

Description of Examination Method:
The assessment is conducted as group work with around six students per team and consists of:

a) a written project report (in form of a slide deck of about 60 content slides) - 70%
b) a presentation to a decision-making audience followed by a Q&A session - 30%

Each group presents its concept in a 10 minute presentation, followed by a Q&A session of up to 5 minutes. The presentation is addressed to a fictional senior management audience and follows the format of a management pitch.

Optionally, guest speakers from industry or consulting may be invited to join the jury.

The objective is to transfer the insights from scientific studies short and precise to senior management and analyze real AI case studies and develop a viable AI value creation concept. The presentation aims to train target group-oriented communication and the confident defense of results in front of a decision-making audience.

Evaluation criteria:
Written report – analytical depth, consistency of value logic, consideration of responsible AI aspects, clarity of argumentation, clarity and effectiveness of slides, and professionalism.
Presentation – persuasiveness of the pitch, quality of answers during the Q&A, and professional delivery.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
For successful participation in the module, students are expected to have a basic understanding of business strategy or digital transformation in order to contextualize AI use cases within value creation frameworks. In addition, very good English skills (at least B2 level) are required.

Beneficial – but not mandatory – are basic knowledge of artificial intelligence and machine learning, as well as fundamentals of statistics (e.g. descriptive statistics, regression analysis).

Content:
1) AI Strategy & Value Potential
Analysis of business models, value narratives, and strategic target visions for AI; evaluation of value creation logic and success metrics.

2) AI Platform & Ecosystem Strategy
Technological architecture decisions (e.g., cloud, MLOps) and design of partner ecosystems to enable scalable AI solutions.

3) People Strategy & AI Leadership
Success factors for talent development, change management, organizational structure, and leadership behavior in AI adoption.

4) Responsible AI & Execution Strategy
Integration of regulatory requirements (incl. EU AI Act), ethical principles, and governance structures into AI execution plans.

5) Generative AI in Practice (BCG Excursion)
Live demonstrations of current GenAI applications, discussion of impact measurement, scaling strategies, and lessons learned from real-world transformation projects.

Intended Learning Outcomes:
After completing the course, students can

1) analyse real-world AI adoption cases to distil recurring success and failure patterns in value creation
2) evaluate strategic, technological, organisational and ethical drivers (incl. EU AI Act) that determine whether AI initiatives deliver business impact
3) design a coherent AI value-creation playbook for a chosen company, covering strategy, tech stack, people and governance
4) justify and communicate the expected value and risk-mitigation logic clearly in a professional report and executive-level presentation

Teaching and Learning Methods:
Lectures: provide a compact theoretical foundation for AI value creation.
Case studies: apply concepts to real company examples, fostering analytical thinking.

Guest lectures: offer current industry insights and highlight success and failure patterns.
Group work: enables students to develop their own value creation playbook, strengthening teamwork, conceptual, and presentation skills.

Media:
The course uses presentation slides as the primary teaching medium. In addition, video recordings of selected interviews with industry experts are shown to provide real-world insights. For certain guest lectures or Q&A sessions, Zoom is used as needed to flexibly integrate external speakers.

Reading List:
No prior reading is required. Optional readings and case materials will be shared during the course to support in-depth understanding and follow-up work.

Responsible for Module:
Welpe, Isabell M.; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Value Creation with AI at Scale: Strategy, Tech, People and Governance (MGT001485, englisch) (Seminar, 2 SWS)
Feldmann S, Merl S, Scheuer A, Tamme T, Treffers T
For further information in this module, please click campus.tum.de or here.

Module Description

SOT53404: Academic Prompt Engineering and Management: a Reflexive Introduction | Academic Prompt Engineering and Management: a Reflexive Introduction

Academic Use of Generative AI: a Lecture on Mastering Techniques, Understanding Background, Embracing Responsibility in Prompt and Bot Engineering and Management

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 75	**Contact Hours:** 15

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

Description of Examination Method:
The module is completed with a written examination as the module examination. The written exam covers the topics and learning outcomes of the module.
In the written exam, students must demonstrate that they can:
• Describe and apply techniques for prompt engineering with large language models, including methods for measuring prompt effectiveness and strategies for ensuring accuracy
• Explain the importance of responsible development and deployment of LLMs
• Analyze human-computer interaction with LLMs and discuss applications in academic research
• Evaluate the design and performance of large language models in terms of fairness, transparency and robustness
• Identify legal and ethical issues related to LLM-generated text
• Assess the transformative potential and progress of LLMs across various domains
The written examination is in the form of short questions and multiple choice questions. Students must complete the exam individually under supervision within a time limit of 30 minutes. Permitted resources are specified by the examiner and communicated to students in advance. The exam is graded according to the grading scale defined in the examination regulations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
There are no prerequisites.

Content:
This module provides students from all parts of Technical University Munich with a comprehensive introduction to prompt and bot engineering for generating text with large language models (LLMs). The course combines hands-on training in effective prompting techniques with an exploration of the legal, ethical, and societal responsibility issues surrounding the use of LLMs for text generation.
Through a series of 10 lectures, students will gain practical skills in prompt engineering while developing a nuanced understanding of the broader implications of this rapidly evolving technology. Topics covered include:
• Overview of techniques for prompt engineering in text generation using LLMs, including methods for measuring prompt effectiveness, advanced techniques, and addressing issues like hallucinations and ensuring accuracy.
• Emphasis on responsible development and deployment of LLMs, focusing on selecting appropriate models, identifying and mitigating biases, ensuring transparency, and evaluating decision-making capacity.
• Exploration of human-computer interaction with LLMs, including decision-making processes, the future of work in the context of LLM-powered text generation, and their applications in academic research.
• Considerations for designing and evaluating large language models, focusing on performance, fairness, transparency, and robustness.
• Discussion on intellectual property, copyright, and other legal and ethical issues related to LLM-generated text.
• The transformative potential and rapid progress of LLMs, highlighting their ability to reshape interactions with technology and information across various domains.

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

• Describe and apply techniques for prompt engineering in text generation using large language models (LLMs), including methods for measuring prompt effectiveness, advanced techniques, and strategies for addressing issues like hallucinations and ensuring accuracy.
• Explain the importance of responsible development and deployment of LLMs, and demonstrate the ability to select appropriate models, identify and mitigate biases, ensure transparency, and evaluate the decision-making capacity of LLMs.
• Analyze human-computer interaction with LLMs, including decision-making processes, and discuss the future of work in the context of LLM-powered text generation and their applications in academic research.
• Evaluate the design and performance of large language models, focusing on key considerations such as fairness, transparency, and robustness.
• Identify and discuss intellectual property, copyright, and other legal and ethical issues related to LLM-generated text.
• Assess the transformative potential and rapid progress of LLMs, and explain their ability to reshape interactions with technology and information across various domains.

Teaching and Learning Methods:
Teaching and learning is structured in two dimensions with appropriate methods:
1. Introductions by Lecturer
• Traditional lectures delivered by the instructor, providing foundational knowledge and key concepts
• Guest lectures by leading experts and practitioners in the field of LLMs and prompt engineering, offering diverse perspectives and real-world insights
• Engaging video lectures for asynchronous learning, allowing students to review complex topics at their own pace
• Interactive in-class discussions and debates on the ethical, legal, and societal implications of LLMs, encouraging critical thinking and active participation

2. Exercises
• Educational games and gamified exercises to reinforce learning and promote engagement with course material
• Regular quizzes and short tests to assess understanding and provide formative feedback
• Peer and self-assessment activities, fostering a collaborative learning environment and developing skills in giving and receiving constructive feedback

Media:
Online lectures, collaborative databases, whiteboards, student polls, slide presentations, quizzes, educational games

Reading List:
Anthropic. (2023). Prompt engineering. https://docs.anthropic.com/en/docs/prompt-engineering
Duan, S. et al. (2023). Denevil: Towards Deciphering and Navigating the Ethical Values of Large Language Models via Instruction Learning. arXiv. https://arxiv.org/abs/2310.11053
Fabiano, N. (2024). AI Act and Large Language Models (LLMs): When critical issues and privacy impact require human and ethical oversight. arXiv. https://arxiv.org/abs/2404.00600
Fabiano, N. (2024). AI Act and Large Language Models (LLMs): When critical issues and privacy impact require human and ethical oversight. arXiv. https://arxiv.org/abs/2404.00600
Gan, W. et al. (2023). Large Language Models in Law: A Survey. arXiv. https://arxiv.org/abs/2312.03718
Harrer, S. (2023). Attention is not all you need: the complicated case of ethically using large language models in healthcare and medicine. Science Direct. https://www.sciencedirect.com/science/article/pii/S2352396423000774
Mökander, J. et al. (2023). Auditing large language models: a three-layered approach. AI Ethics. https://doi.org/10.1007/s43681-023-00289-2
Prompt Engineering Guide. (2023). Prompting Techniques. https://www.promptingguide.ai/techniques
Quan, X. (2024). Enhancing Ethical Explanations of Large Language Models through Iterative Symbolic Refinement. arXiv. https://arxiv.org/abs/2402.00745
Weidinger, L. et al. (2021). Ethical and social risks of harm from Language Models. arXiv. https://arxiv.org/abs/2112.04359

Yan, L. (2023). Practical and Ethical Challenges of Large Language Models in Education: A Systematic Scoping Review. arXiv. https://arxiv.org/abs/2303.13379
Zhang, J. (2023). Ethical Considerations and Policy Implications for Large Language Models: Guiding Responsible Development and Deployment. arXiv. https://arxiv.org/abs/2308.02678

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Academic Prompt Engineering and Management: a Reflexive Introduction (Vorlesung mit integrierten Übungen, 1 SWS)
Djeffal C
For further information in this module, please click campus.tum.de or here.

Module Description

SOT53405: Academic Prompt Engineering and Management: Responsible Use in Action | Academic Prompt Engineering and Management: Responsible Use in Action

Academic Use of Generative AI: a Seminar on Mastering Techniques, Understanding Background, Embracing Responsibility in Prompt and Bot Engineering and Management

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 75	**Contact Hours:** 15

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

Description of Examination Method:
The module is completed with a written examination as the module examination. The written exam covers the topics and learning outcomes of the module.
In the written exam, students must demonstrate that they can:
• Describe and apply techniques for prompt engineering with large language models, including methods for measuring prompt effectiveness and strategies for ensuring accuracy
• Explain the importance of responsible development and deployment of LLMs
• Analyze human-computer interaction with LLMs and discuss applications in academic research
• Evaluate the design and performance of large language models in terms of fairness, transparency and robustness
• Identify legal and ethical issues related to LLM-generated text
• Assess the transformative potential and progress of LLMs across various domains
The written examination is in the form of short questions and multiple choice questions. Students must complete the exam individually under supervision within a time limit of 30 minutes. Permitted resources are specified by the examiner and communicated to students in advance. The exam is graded according to the grading scale defined in the examination regulations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should be familiar with the contents of the introductory module SOT53404.

Content:
This module builds on the lecture and provides students from all parts of Technical University Munich with a solidification of knowledge concerning the use of generative AI. The course combines hands-on training in effective prompting techniques with an exploration of the legal, ethical, and societal responsibility issues surrounding the use of LLMs for text generation. Through a two-day interactive seminar, students will deepen their knowledge by using practical skills in prompt engineering while developing a nuanced understanding of the broader implications of this rapidly evolving technology. Topics covered include:
• Application of techniques for prompt engineering in text generation using LLMs, including methods for measuring prompt effectiveness, advanced techniques, and addressing issues like hallucinations and ensuring accuracy.
• Implementation of responsible development and deployment of LLMs, focusing on selecting appropriate models, identifying and mitigating biases, ensuring transparency, and evaluating decision-making capacity.
• In-depth exploration of human-computer interaction with LLMs, including decision-making processes, the future of work in the context of LLM-powered text generation, and their applications in academic research.
• Considerations for designing and evaluating large language models, focusing on performance, fairness, transparency, and robustness.
• Application of requirements of intellectual property, copyright, fairness, diversity and other legal and ethical issues related to LLM-generated text.
• The transformative potential and rapid progress of LLMs, highlighting their ability to reshape interactions with technology and information across various domains.

Intended Learning Outcomes:
Upon successful completion of this module, students will be able to:
- Design and implement advanced prompt engineering strategies for complex academic tasks, including systematic approaches to chain-of-thought reasoning, few-shot learning, and context optimization.
- Develop and execute comprehensive prompt testing frameworks to evaluate and improve prompt effectiveness, including quantitative metrics and qualitative assessment methods.
- Create and manage automated workflows for academic research using LLMs, incorporating proper documentation, version control, and quality assurance measures.
- Construct and validate bias detection and mitigation strategies in LLM applications, with particular focus on academic integrity and research validity.
- Synthesize and apply ethical frameworks for responsible AI use in academic settings, including developing guidelines for appropriate LLM integration in research methodologies.
- Lead and coordinate collaborative projects involving LLM integration, demonstrating the ability to manage stakeholder expectations and ensure compliance with academic standards.

Teaching and Learning Methods:
Workshop
• Based on the learnings of the lecture

• Hands-on design workshop and maker sessions, allowing students to experiment with prompt engineering techniques and develop practical skills in a supportive environment
• Open-ended problem-solving exercises, challenging students to apply their knowledge to real-world scenarios and develop creative solutions
• Pair programming and code review activities, promoting collaboration, knowledge sharing, and the development of best practices in prompt engineering and responsible AI development.
• Possibility for successful teams to be represented in an online plattform built for that purpose

Media:
collaborative databases, whiteboards, student polls, slide presentations, quizzes, educational games

Reading List:
Anthropic. (2023). Prompt engineering. https://docs.anthropic.com/en/docs/prompt-engineering
Duan, S. et al. (2023). Denevil: Towards Deciphering and Navigating the Ethical Values of Large Language Models via Instruction Learning. arXiv. https://arxiv.org/abs/2310.11053
Fabiano, N. (2024). AI Act and Large Language Models (LLMs): When critical issues and privacy impact require human and ethical oversight. arXiv. https://arxiv.org/abs/2404.00600
Fabiano, N. (2024). AI Act and Large Language Models (LLMs): When critical issues and privacy impact require human and ethical oversight. arXiv. https://arxiv.org/abs/2404.00600
Gan, W. et al. (2023). Large Language Models in Law: A Survey. arXiv. https://arxiv.org/abs/2312.03718
Harrer, S. (2023). Attention is not all you need: the complicated case of ethically using large language models in healthcare and medicine. Science Direct. https://www.sciencedirect.com/science/article/pii/S2352396423000774
Mökander, J. et al. (2023). Auditing large language models: a three-layered approach. AI Ethics. https://doi.org/10.1007/s43681-023-00289-2
Prompt Engineering Guide. (2023). Prompting Techniques. https://www.promptingguide.ai/techniques
Quan, X. (2024). Enhancing Ethical Explanations of Large Language Models through Iterative Symbolic Refinement. arXiv. https://arxiv.org/abs/2402.00745
Weidinger, L. et al. (2021). Ethical and social risks of harm from Language Models. arXiv. https://arxiv.org/abs/2112.04359
Yan, L. (2023). Practical and Ethical Challenges of Large Language Models in Education: A Systematic Scoping Review. arXiv. https://arxiv.org/abs/2303.13379
Zhang, J. (2023). Ethical Considerations and Policy Implications for Large Language Models: Guiding Responsible Development and Deployment. arXiv. https://arxiv.org/abs/2308.02678

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Academic Prompt Engineering and Management: Responsible Use in Action (Workshop, 1 SWS)
Djeffal C

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

Module Description

SOT53406: Open Data - Open Science (Introduction) | Open Data - Open Science (Introduction)

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The module will be assessed in a 90-minute written exam. The exam allows students to demonstrate their knowledge of principles of open science and open research and illustrate their evaluation skills of political and economic dimensions in knowledge production, as well as their ability to analyze the impact of different initiatives on a variety of fields.

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
The module is designed to provide students with a comprehensive understanding of the principles and practices of openness in scientific research and data management. The course is structured to highlight the transformative potential of open science, in particular open access to publications, open research data, and open source for science in society, emphasizing not only aspects of research integrity or innovation (such as reproducibility), but also aspects of democratizing access and use of knowledge. It also aims to foster students’ understanding of the Open Science movement, its impact on science and society, and, more generally, current transformation in research practices and governance. The module builds around the research conducted within the PHIL_OS project (www.opensciencestudies.eu), one of the leading research groups worldwide working on these issues, and therefore focuses on the cutting-edge of research on Open Science. Through case studies, students will explore foundational concepts such as the political economy of scientific knowledge production and the significance of open science initiatives. The course will also cover key topics including open source projects, open infrastructures, and citizen science, illustrated with real-world case studies to demonstrate their impact on various fields.

In terms of disciplinary domain, we will discuss emerging research within the fields of philosophy, history and social studies of science and technology, as well as meta-research (sometimes also referred to as “research on research”). Topics encompass, but are not be limited to: the reproducibility crisis; information quality; inequity and injustice across research environments; data-intensive technologies and AI; data management; cooperation and coordination within and across scientific institutions; citizen science and public science; science governance; scientific modelling and epistemology. See the detailed schedule for more details. Attendees are required to attend sessions regularly, study the readings for each week in advance of the meeting, and come prepared for discussion.

Intended Learning Outcomes:
By the end of this module, students will be able to:
- describe the principles of open science and open (research) data.
- understand the impact of open initiatives like the Human Genome Project across several societal domains, such as research, politics, education, economy, security
- apply open science practices in their own research fields

Teaching and Learning Methods:
The module will consist of a lecture, which introduces participants to the principles and the importance of Open Data for research and industry and to the political economy of knowledge production. This will be done with case studies as the human genome project or examples of open infrastructure and citizen science. Attendees are required to attend sessions regularly, study the readings for each week in advance of the meeting, and come prepared for discussion.

Media:
Reader, PowerPoint

Reading List:
Fecher, B., & Friesike, S. (2014). Open science: one term, five schools of thought (pp. 17-47). Springer International Publishing.
Gold, E. R. (2021). The fall of the innovation empire and its possible rise through open science. Research Policy, 50(5), 104226.
Heimstädt, M., & Friesike, S. (2021). The odd couple: Contrasting openness in innovation and science. Innovation, 23(3), 425-438.
Leonelli, S. (2023) Philosophy of Open Science. Cambridge University Press.
Levin, N. and Leonelli, S. (2016) How Does One “Open” Science? Questions of Value in Biological Research. Science, Technology and Human Values 42 (2): 280-305. DOI: 10.1177/0162243916672071
Maxson Jones, K., Ankeny, R. A., & Cook-Deegan, R. (2018). The Bermuda Triangle: The pragmatics, policies, and principles for data sharing in the history of the human genome project. Journal of the History of Biology, 51(4), 693-805.
Ross-Hellauer, T., Reichmann, S., Cole, N. L., Fessl, A., Klebel, T., & Pontika, N. (2022). Dynamics of cumulative advantage and threats to equity in open science: a scoping review. Royal Society open science, 9(1), 211032.

Salazar, A., Wentzel, B., Schimmler, S., Gläser, R., Hanf, S., & Schunk, S. A. (2023). How Research Data Management Plans Can Help in Harmonizing Open Science and Approaches in the Digital Economy. Chemistry–A European Journal, 29(9), e202202720.
Tyfield, D., Lave, R., Randalls, S., & Thorpe, C. (Eds.). (2017). The routledge handbook of the political economy of science (pp. 21-31). London, UK: Routledge.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Open Data - Open Science (Vorlesung, 2 SWS)
Jones E, Leonelli S
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86060: Data Regulation & Law (3 ECTS) | Data Regulation & Law (3 ECTS)

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The module exam is a written examination.
The written examination will cover topics from the field of privacy regulation (especially GDPR).
The examination will last 60 minutes and will consist of various questions (essay and/or multiple choice).
The aim of the written examination is to demonstrate knowledge in privacy and data protection law. With the processing of the examination students demonstrate that they are able to remember and name the fundamental principles of privacy and data protection law. Furthermore, they will show that they are able to identify and explain important questions and current challenges in the field of privacy and data protection law and regulation with an international perspective.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The module covers the following topics.
GDPR & Foundations: policy, fundamental rights, history and relevance; Scope; Data subjects, controller, Joint controller, processors, third parties; Principles; Principle of Lawfulness; Data subject rights; Obligations of controllers und processors; Third country transfers; Enforcement, remedies, liability athorities, damages. Data protection legislation for specific sectors and conflicts.

Intended Learning Outcomes:
After the completition of the module the students will be able to remember the basics concepts and implicatons of privacy and data protection law. This includes the policy, fundamental rights, history and relevance of GDPR, as well as the material und territorial scope. Furthermore the students will be able to repeat basic principals of data subjects rights, in particular with respect to access, erasure, object as well as in obligations of data controllers and processors.

Teaching and Learning Methods:
The module consists of a master´s lecture. The topics of the module are presented via slides and presentations in the lecture hall or a hybrid format. The teaching aim to stimulate discussions based on presentations and questions. In addition the module will equip students with the necessary skills to identify and discuss current research on privacy and data protection law and regulation, as well as to communicate their effectiveness and implications, and shed light on their impact on society. During the lecture parts, new topics will be presented and explained.

Media:
PowerPoint presentations

Reading List:
Handbook on European data protection law, author(s): Council of Europe , European Court of Human Rights , European Data Protection Supervisor , European Union Agency for Fundamental Rights (EU body or agency), Link: https://op.europa.eu/en/publication-detail/-/publication/5b0cfa83-63f3-11e8-ab9c-01aa75ed71a1

Responsible for Module:
Paal, Boris; Prof. Prof. Dr. Dr. jur.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86060, SOT86061) Data Regulation & Law (Vorlesung, 2 SWS)
Paal B (Djebbari S, Krikis K)
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86061: Data Regulation & Law (6 ECTS) | Data Regulation & Law (6 ECTS)

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The module examination consists of an exercise. The exercise consisting of two graded exercise sheets (Homework) and a written test.
The two equally weighted exercise sheets (Homework) account for 40% of the final grade; the written test at the end of the semester for another 60%.
Both, the written test as well as the two written homework exercises will cover topics from the field of privacy and data economy regulation.
The written test will last 60 minutes and will consist of various questions (essay and/or multiple choice). The aim of the written test is to demonstrate knowledge in privacy and data protection law and data economy regulation. The two written homework exercises will be discussed and presented in class.
The module examination demonstrates that they are able to remember and name the fundamental principles of privacy and data protection law and data economy regulation. Furthermore, they will show that they are able to compare, use and explain legal principles with respect to current challenges in the field of privacy and data protection law and regulation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
The module covers the following topics.

Data Governance Act: Data sharing; Data altruism; Data intermediaries
Data Act: Access to data; cloud switching; interoperability
GDPR & Foundations: policy, fundamental rights, history and relevance; Scope; Data subjects, controller, Joint controller, processors, third parties; Principles; Principle of Lawfulness; Data subject rights; Obligations of controllers und processors; Third country transfers; Enforcement, remedies, liability athorities, damages. Data protection legislation for specific sectors and conflicts

Intended Learning Outcomes:
After the completition of the module the students will be able to understand the core concepts and implicatons of data, privacy and data protection law. This includes the policy, fundamental rights, history and relevance of GDPR, as well as the material und territorial scope. Additionally the students will be able to understand the core principles of the European Data Act. Furthermore the students will be able to discuss basic principles of data subjects rights, in particular with respect to access, erasure, object as well as in obligations of data controllers and processors. Additionally students will be able to understand, analyze and discuss current research on data, privacy and data protection law and regulation. After completion students will also be able to assess the impact data protection law and regulation have on society.

Teaching and Learning Methods:
The module consists of a master´s lecture and associated case studies. The topics of the module are presented via slides and presentations in the lecture hall or a hybrid format. Both the teaching format and the associated in-class exercises aim to stimulate discussions based on presentations and questions. In addition the module will equip students with the necessary skills to understand and critically discuss current research on data, privacy and data protection law and regulation, as well as to communicate their effectiveness and implications, and shed light on the respective impact on society. During the lecture parts, new topics will be presented and explained. In the in-class exercises, these concepts will be implemented and applied in case studies.

Media:
PowerPoint presentations

Reading List:
Handbook on European data protection law, author(s): Council of Europe , European Court of Human Rights , European Data Protection Supervisor , European Union Agency for Fundamental Rights (EU body or agency), Link: https://op.europa.eu/en/publication-detail/-/publication/5b0cfa83-63f3-11e8-ab9c-01aa75ed71a1

Responsible for Module:
Paal, Boris; Prof. Prof. Dr. Dr. jur.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86060, SOT86061) Data Regulation & Law (Vorlesung, 2 SWS)
Paal B (Djebbari S, Krikis K)

(SOT86061) Data Regulation & Law (part of 6 ECTS module) (Übung, 2 SWS)
Paal B (Djebbari S, Krikis K)
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86074: Aligning Generative AI to Social Values (6 ECTS) | Aligning Generative AI to Social Values (6 ECTS)

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The module examination consists of a project work. The project involves group work, a written report (10-15 pages), and a final presentation (5 minutes). The written report counts for 90 % of the module grade, and the presentation for 10 %. The project will be worked on in teams, and a responsible machine learning project will be pursued in a key area of their interest. Through the project, students will demonstrate their ability to identify and mitigate biases in generative AI models and showcase their skill in designing and implementing AI models, prioritizing ethical standards, and reflecting diverse social values. With the written report, the students show their understanding of the principles and frameworks for aligning generative AI systems with societal values and ethical considerations. They further demonstrate their ability to critically evaluate the impact of generative AI technologies on different social dimensions. Through the presentation, students prove that they are able to present and discuss their results to a specialist audience understandably and appropriately.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of machine learning concepts and algorithms is recommended, though not strictly required. The same applies for coding skills. An interest in ethics, social science, and policy aspects related to technology would be advantageous for engaging with the course content.

Content:
This module explores the intersection of generative AI and social values, focusing on ethical considerations, bias mitigation, and the development of AI systems that reflect diverse societal

values. Students will engage with theoretical frameworks, practical tools, and case studies to understand and address the ethical challenges in generative AI.
Course Content:
1. Introduction to Generative AI and Social Values
Overview of generative AI technologies
Importance of aligning AI with societal values
Ethical principles in AI (fairness, accountability, transparency, inclusivity)
2. Ethical Frameworks and Principles
Key ethical theories and their application to AI
Existing frameworks for ethical AI
Case studies on ethical AI failures and successes
3. Understanding and Mitigating Bias in Generative AI
Types and sources of bias in AI models
Methods for detecting and mitigating bias
Practical exercises in bias identification and mitigation
4. Transparency and Accountability in AI
Importance of transparency in AI systems
Techniques for improving transparency
Ensuring accountability in AI deployment
5. Auditing and Red Teaming Approaches
Introduction to auditing AI systems
Red teaming methodologies for stress-testing AI models
Hands-on projects in auditing and red teaming generative AI
6. Aligning Large Language Models with Societal Values
Challenges specific to large language models (e.g., GPT, BERT)
Techniques for aligning language models with ethical standards
Practical projects in fine-tuning and aligning language models
7. Balancing Innovation and Ethical Responsibility
Case studies on innovation vs. ethical dilemmas in AI
Strategies for responsible AI development
Policy implications and regulatory considerations

Intended Learning Outcomes:
Upon successful completion of this module, students will: Develop a thorough understanding of the principles and frameworks for aligning generative AI systems with societal values and ethical considerations. Be able to critically evaluate the impact of generative AI technologies on various social dimensions, including fairness, accountability, transparency, and inclusivity. Acquire skills to identify and mitigate biases in generative AI models, ensuring more equitable and just outcomes.Gain practical experience in designing and implementing AI models that prioritize ethical standards and reflect diverse social values.Understand the challenges and complexities of balancing innovation with ethical responsibility in the deployment of generative AI. Learn to collaborate effectively in interdisciplinary teams to conceptualize, design, and execute projects focused on aligning AI with societal needs.

Teaching and Learning Methods:
The module consists of a lecture and a seminar.
In the lecture students will be introduced to key concepts in Generative AI & Social Values. During the lecture, there will be slides and presentations, which will describe different parts key concepts. Students will be answer questions and perform short excercises, through which they can prove their understanding of the course content. In the seminar, students will have to apply the learned concepts in practice. They will form groups, learn how to work as teams, and answer a specific research question on aligning Generative AI models to social values. Through the final presentation and the delivery of the project they will prove their expertise in AI Alignment.

Media:
computer, presentations, videos

Reading List:
Gabriel, Iason. "Artificial intelligence, values, and alignment." Minds and machines 30, no. 3 (2020): 411-437.

Ryan, Michael J., William Held, and Diyi Yang. "Unintended Impacts of LLM Alignment on Global Representation." arXiv preprint arXiv:2402.15018 (2024).

Casper, Stephen, Xander Davies, Claudia Shi, Thomas Krendl Gilbert, Jérémy Scheurer, Javier Rando, Rachel Freedman et al. "Open problems and fundamental limitations of reinforcement learning from human feedback." arXiv preprint arXiv:2307.15217 (2023).

Shi, Weiyan, Ryan Li, Yutong Zhang, Caleb Ziems, Raya Horesh, Rogério Abreu de Paula, and Diyi Yang. "CultureBank: An Online Community-Driven Knowledge Base Towards Culturally Aware Language Technologies." arXiv preprint arXiv:2404.15238 (2024).

Responsible for Module:
Papakyriakopoulos, Orestis; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86074) Aligning Generative AI to Social Values (part of 6 ECTS module) (Seminar, 2 SWS)
Papakyriakopoulos O

(SOT86097, SOT86074) Aligning Generative AI to Social Values (Vorlesung, 2 SWS)
Papakyriakopoulos O
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86076: Open Data - Open Science | Open Data - Open Science

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The module will be assessed in a scientific paper (3000 words) and a 90-minute written exam. The written exam allows students to demonstrate their knowledge of the principles of open science and open research and their understanding of political and economic dimensions in knowledge production. In the scientific paper students demonstrate that they are able to discuss the political and economic dimensions of knowledge production. The paper will be on a topic inspired by one of the module sessions as listed below. The essay needs to propose and defend a solution to one of the challenges identified and debated during the seminars. Essays need to be written in the 1st person ("I will argue that..") and make use of relevant scholarly literature, with at least 8 academic sources cited and discussed within the essay.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The module is designed to provide students with a comprehensive understanding of the principles and practices of openness in scientific research and data management. The course is structured to highlight the transformative potential of open science, in particular open access to publications, open research data, and open source for science in society, emphasizing not only aspects of research integrity or innovation (such as reproducibility), but also aspects of democratizing access and use of knowledge. It also aims to foster students' understanding of the Open Science movement, its impact on science and society, and, more generally, current transformation in research practices and governance. The module builds around the research conducted within the PHIL_OS project (www.opensciencestudies.eu), one of the leading research groups worldwide working on these issues, and therefore focuses on the cutting-edge of research on Open Science.

Through case studies, students will explore foundational concepts such as the political economy of scientific knowledge production and the significance of open science initiatives. The course will also cover key topics including open source projects, open infrastructures, and citizen science, illustrated with real-world case studies to demonstrate their impact on various fields. In terms of disciplinary domain, we will discuss emerging research within the fields of philosophy, history and social studies of science and technology, as well as meta-research (sometimes also referred to as “research on research”). Topics encompass, but are not be limited to: the reproducibility crisis; information quality; inequity and injustice across research environments; data-intensive technologies and AI; data management; cooperation and coordination within and across scientific institutions; citizen science and public science; science governance; scientific modelling and epistemology. See the detailed schedule for more details. Attendees are required to attend sessions regularly, study the readings for each week in advance of the meeting, and come prepared for discussion. Through case studies, students will explore foundational concepts such as the political economy of scientific knowledge production and the significance of open science initiatives.

In addition to theoretical knowledge, the course incorporates hands-on exercise components that engage students in practical applications of open access, open research data, and open source. Students will work in groups to discover, clean, analyze, and present data relevant to their fields of study. This exercise is designed to build practical skills and encourage collaboration. This dual approach ensures that students not only understand the importance of open science and open data but also gain the practical experience necessary to implement these practices in their future careers. By the end of the course, students will be well-equipped to contribute to the growing movement towards openness in research and public administration, fostering a more inclusive and accessible knowledge economy.

Intended Learning Outcomes:
By the end of this module, students will be able to:
Understand the principles and importance of open science and open (research) data.
Analyze the impact of open initiatives like the Human Genome Project across several societal domains, such as research, politics, education, economy, security and more.
Evaluate critically the political and economic dimensions of knowledge production.
Gain practical skills in data discovery, cleaning, analysis, and presentation.
Apply open science practices in their own research fields.
Contributors will also gain understanding of cutting-edge debates in the philosophy and social studies of science, especially life and environmental sciences; science governance and current global transformations; inequity and injustice in scientific knowledge production and use. Contributors will also gain skills in discussing complex problems for science and society, articulating and defending their own position on such issues, and researching background and solutions in a scholarly, rigorous manner.

Teaching and Learning Methods:
The module will consist of a lecture and a seminar. The lectures will take the form of presentations given by experts in each topic with a discussion around readings circulated in advance (including

in many cases draft manuscripts of work that has not yet published). The seminars will take the form of updates and discussions among students and participants to the PHIL_OS project, thereby bringing the students right into the heart of ongoing research on these issues, including the latest policy and scientific developments.

Media:
Reader, PowerPoint

Reading List:
Fecher, B., & Friesike, S. (2014). Open science: one term, five schools of thought (pp. 17-47). Springer International Publishing.
Gold, E. R. (2021). The fall of the innovation empire and its possible rise through open science. Research Policy, 50(5), 104226.
Heimstädt, M., & Friesike, S. (2021). The odd couple: Contrasting openness in innovation and science. Innovation, 23(3), 425-438.
Leonelli, S. (2023) Philosophy of Open Science. Cambridge University Press.
Levin, N. and Leonelli, S. (2016) How Does One “Open” Science? Questions of Value in Biological Research. Science, Technology and Human Values 42 (2): 280-305. DOI: 10.1177/0162243916672071
Maxson Jones, K., Ankeny, R. A., & Cook-Deegan, R. (2018). The Bermuda Triangle: The pragmatics, policies, and principles for data sharing in the history of the human genome project. Journal of the History of Biology, 51(4), 693-805.
Ross-Hellauer, T., Reichmann, S., Cole, N. L., Fessl, A., Klebel, T., & Pontika, N. (2022). Dynamics of cumulative advantage and threats to equity in open science: a scoping review. Royal Society open science, 9(1), 211032.
Salazar, A., Wentzel, B., Schimmler, S., Gläser, R., Hanf, S., & Schunk, S. A. (2023). How Research Data Management Plans Can Help in Harmonizing Open Science and Approaches in the Digital Economy. Chemistry–A European Journal, 29(9), e202202720.
Tyfield, D., Lave, R., Randalls, S., & Thorpe, C. (Eds.). (2017). The routledge handbook of the political economy of science (pp. 21-31). London, UK: Routledge.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Open Data - Open Science (Seminar, 2 SWS)
Jones E, Leonelli S

Introduction to Open Data - Open Science (Vorlesung, 2 SWS)
Jones E, Leonelli S
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86097: Aligning Generative AI to Social Values (3 ECTS) | Aligning Generative AI to Social Values (3 ECTS)

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
The module examination consists of a written exam (Multiple Choice Test) (60 minutes). With the Multiple Choice Test, the students show their understanding of the principles and frameworks for aligning generative AI systems with societal values and ethical considerations. They further demonstrate their ability to critically evaluate the impact of generative AI technologies on different social dimensions and to understand the challenges and complexities of balancing innovation with ethical responsibility in deploying of generative AI.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of machine learning concepts and algorithms is recommended, though not strictly required. The same applies for coding skills. An interest in ethics, social science, and policy aspects related to technology would be advantageous for engaging with the course content.

Content:
This module explores the intersection of generative AI and social values, focusing on ethical considerations, bias mitigation, and the development of AI systems that reflect diverse societal values. Students will engage with theoretical frameworks, practical tools, and case studies to understand and address the ethical challenges in generative AI.
Course Content:
1. Introduction to Generative AI and Social Values
Overview of generative AI technologies
Importance of aligning AI with societal values

Ethical principles in AI (fairness, accountability, transparency, inclusivity)
2. Ethical Frameworks and Principles
Key ethical theories and their application to AI
Existing frameworks for ethical AI
Case studies on ethical AI failures and successes
3. Understanding and Mitigating Bias in Generative AI
Types and sources of bias in AI models
Methods for detecting and mitigating bias
Practical exercises in bias identification and mitigation
4. Transparency and Accountability in AI
Importance of transparency in AI systems
Techniques for improving transparency
Ensuring accountability in AI deployment
5. Auditing and Red Teaming Approaches
Introduction to auditing AI systems
Red teaming methodologies for stress-testing AI models
Hands-on projects in auditing and red teaming generative AI
6. Aligning Large Language Models with Societal Values
Challenges specific to large language models (e.g., GPT, BERT)
Techniques for aligning language models with ethical standards
Practical projects in fine-tuning and aligning language models
7. Balancing Innovation and Ethical Responsibility
Case studies on innovation vs. ethical dilemmas in AI
Strategies for responsible AI development
Policy implications and regulatory considerations

Intended Learning Outcomes:
Upon successful completion of this module, students will:
Develop a thorough understanding of the principles and frameworks for aligning generative AI systems with societal values and ethical considerations.
Be able to critically evaluate the impact of generative AI technologies on various social dimensions, including fairness, accountability, transparency, and inclusivity.
Acquire skills to identify and mitigate biases in generative AI models, ensuring more equitable and just outcomes.
Understand the challenges and complexities of balancing innovation with ethical responsibility in the deployment of generative AI.

Teaching and Learning Methods:
The module consists of a lecture.
In the lecture students will be introduced to key concepts in Generative AI & Social Values. During the lecture, there will be slides and presentations, which will describe different parts key concepts.

Students will answer questions and perform short excercises, through which they can prove their understanding of the course content.

Media:
computer, presentations, videos

Reading List:
Gabriel, Iason. "Artificial intelligence, values, and alignment." Minds and machines 30, no. 3 (2020): 411-437.

Ryan, Michael J., William Held, and Diyi Yang. "Unintended Impacts of LLM Alignment on Global Representation." arXiv preprint arXiv:2402.15018 (2024).

Casper, Stephen, Xander Davies, Claudia Shi, Thomas Krendl Gilbert, Jérémy Scheurer, Javier Rando, Rachel Freedman et al. "Open problems and fundamental limitations of reinforcement learning from human feedback." arXiv preprint arXiv:2307.15217 (2023).

Shi, Weiyan, Ryan Li, Yutong Zhang, Caleb Ziems, Raya Horesh, Rogério Abreu de Paula, and Diyi Yang. "CultureBank: An Online Community-Driven Knowledge Base Towards Culturally Aware Language Technologies." arXiv preprint arXiv:2404.15238 (2024).

Responsible for Module:
Papakyriakopoulos, Orestis; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86097, SOT86074) Aligning Generative AI to Social Values (Vorlesung, 2 SWS)
Papakyriakopoulos O
For further information in this module, please click campus.tum.de or here.

Module Description

WI000285: Innovative Entrepreneurs - Leadership of High-Tech Companies | Innovative Entrepreneurs - Leadership of High-Tech Companies

Version of module description: Gültig ab summerterm 2021

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

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

Description of Examination Method:
The examination performance is achieved through individual project work, which is divided into three phases. In the first phase, the students intensely engage themselves over a period of six to eight weeks with a self-chosen "Inner Development Challenge" from one of the following topic areas: Relationship to Self, Cognitive Skills, Caring for Others and the World, Social Skills, and Driving Change. Subsequently, in the reflection phase, a written reflection paper is produced in which the students critically reflect on their experiences and draw conclusions for their future.
In the Peer feedback phase, the students read and analyze five reflection papers of their fellow students. This fosters the students' ability to critically analyze their own works as well as the works of others and to give and receive effective feedback.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
- Knowledge: No special requirements, willingness to participate
- Abilities: Identifying opportunities; proactiveness; communication; commitment
- Skills: openness; analytical thinking; visual thinking; self-motivation; networking

Content:
The objective of the module is to inspire and motivate the participants coming from various disciplines for an entrepreneurial career, and to give them a basic understanding about founding and managing technology- and growth-oriented companies. To serve this purpose, the module

provides an introduction to the topic of (effectual) entrepreneurship, as well as guest lectures by outstanding founders, entrepreneurs, managers, and investors on selected topics, such as:

1. The entrepreneurial ecosystem
2. Founding of companies for students and scientists
3. How to develop an idea into a market-ready product
4. Financing of startups
5. Corporate growth
6. Creating and managing an entrepreneurial culture
7. Strategic business management
8. Innovation management
9. Corporate finance
10. Business succession

Moreover, for self-motivated participants, there is ample opportunity for personal development through interactive workshops, closed networking events.

Intended Learning Outcomes:
Upon successful completion of this module, participants will be able to...
- understand the entrepreneurial mindset
- recognize and develop personal strengths
- develop and implement personal ideas
- understand Design Thinking methodology

Moreover through guest speakers' lectures and optional workshops participants will be empowered to:
- realize opportunities and challenges associated with the founding and managing of technology- and growth-oriented companies;
- create a personal roadmap for entrepreneurial success.

Thus, students familiarize with topics like opportunity recognition, innovation management, growth, leadership, and the facets of entrepreneurship. In doing that, they are enabled to see, realize, and experience the multiplicity in the everyday life of an entrepreneur, entrepreneurial personalities, as well as entrepreneurial skills and motivations.

Teaching and Learning Methods:
As guest lecturers, each week an outstanding founder, entrepreneur, manager, or investor, spanning a wide-ranging industrial spectrum, is hosted to report on their individual entrepreneurial careers.

At the end of each lecture, the participants can actively engage in discussions with the guest speaker during an open session.

Moreover, in context of a workshop, the participants venture their own personal qualities and skills to understand in a structured way their own entrepreneurial identity. In doing that, they focus on their individual strengths and resources to develop a plan to be entrepreneurial.

The module also provides participants with ample opportunity to network with people from the entrepreneurial environment of TUM.

Media:
- Lecture slides downloadable
- Online discussion forum (e.g., for questions and feedback on guest lectures)
- Handouts (distributed online)

Reading List:
Read, S., S arasvathy, S., Dew, N., Wiltbank, R., & Ohlsson, A. V. (2016). Effectual Entrepreneurship. Taylor & Francis

Responsible for Module:
Schönenberger, Helmut; Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Innovative Entrepreneurs - Leadership of High-Tech Companies (WI000285, englisch) (Vorlesung, 2 SWS)
Schönenberger H [L], Schönenberger H, Schuster C
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001309: Advanced Seminar Marketing, Strategy, Leadership & Management: Life Mastery: Essential Human, Social, and Financial Skills They Don’t Teach in School | Advanced Seminar Marketing, Strategy, Leadership & Management: Life Mastery: Essential Human, Social, and Financial Skills They Don’t Teach in School

Version of module description: Gültig ab summerterm 2023

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:
The examination consists of
1) an individual presentation (25% of the final grade)
2) an individual written work (75% of the final grade).

In the examination, students demonstrate that they
- have understood an assigned topic in depth and have demonstrated the most important aspects in a way that is comprehensible to their fellow students
- have identified and prepared practical fields of application for this topic
- have presentation and communication skills that enable them to present their findings on the topic in a clear and structured manner and discuss the applicability of their findings to business practice

Repeat Examination:
Next semester

(Recommended) Prerequisites:
IMPORTANT: Available seats will be allocated based on academic eligibility, relevant experience and skills.

Content:
This course exists to cover and convey all the content that otherwise falls short - whether in school, college, education, and public exchange - so that students of all disciplines can gain and benefit from this knowledge. What really matters in life, work and career? Many of the unwritten laws

and connections are discovered by many people only late in life and are often only passed on informally among themselves.
The aim of this seminar is to close these "white spots" and "gaps" by conveying practical, useful content, the knowledge and understanding of which represents real added value for work, career and other areas of life.
In doing so, this course focuses on three overarching topics:
- personal competencies
(such as career planning and self-leadership; e.g., "How do I know what I really want?", "How can I set critical priorities for my career?", or "How can I strategically use microhabits to achieve my goals?").
- social skills
(such as communication and relationship management; e.g., "How do I generate positive feedback?" or "How do I deal with difficult counterparts?"),
- financial competencies
(such as planning finances, asset, and retirement; e.g., "What is passive income and how can I take advantage of it?").

Intended Learning Outcomes:
Students who have attended this seminar will possess
- a comprehensive understanding of key design opportunities in work, career, and life
- knowledge of major issues related to personal, social, and financial skills, as well as promising approaches and methods to address these issues
and have acquired practical skills in
- personal, social, and financial competencies,
- critical thinking, reflection, and application of concepts and scientific findings to concrete challenges, and
- engaging and descriptive preparation of content for practical application.
- basic knowledge of working scientifically.

Teaching and Learning Methods:
In this seminar, participants will receive input on the topics covered in various thematic blocks, as well as working materials for self-study and reappraisal. Subsequently, the contents are deepened in the seminar in the context of exercises, role plays, reflections, presentations and discussions. As part of the examination, the participants will work on a topic from one of the three areas in depth and in detail and prepare this didactically in such a way that all other course participants can also benefit from it. During the seminar, they will have the opportunity to present and discuss this topic and to receive feedback on the developed content following the presentation as well as in the context of a peer-review process. Based on this, the participants will further elaborate, concretize and vividly prepare their topic in the course of the semester.

Media:
Activity-based learning, interactive teaching, flipped classroom, group discussions, presentations, practical exercises, reflection, literature, script.

Reading List:
• Dalio, R. (2017). Principles: Life and work. Simon and Schuster.
• Housel, M. (2020). The Psychology of Money: Timeless lessons on wealth, greed, and happiness. Harriman House Limited.
• Carnegie, D. (2014). Wie man Freunde gewinnt: Die Kunst, beliebt und einflussreich zu werden. S. Fischer Verlag.

Responsible for Module:
Welpe, Isabell M.; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Marketing, Strategy, Leadership & Management (MGT001309, englisch): Life Mastery: Essential Human, Social, and Financial Skills They Don’t Teach in School (Seminar, 4 SWS)
Welpe I, Born N, Hochstraßer S
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001348: Innovation Sprint | Innovation Sprint

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 140	**Contact Hours:** 40

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

Description of Examination Method:
Combination of group and individual project assignment - final examination consists of two components, each carrying 50% of the final course grade: (1) a 5 minute group presentation plus 10 minutes Q&A and feedback at the end of the course and (2) an individual reflection paper of ca. 2,500 words.
Students will present to the class, the lecturer and the partner how the team identified an attractive opportunity in a suitable market, understood the customers' / users' needs in the process and, as a result, proposed a sustainable business model that balances people, planet and profit.

In a written reflection paper, every student will reflect upon and consolidate their individual learnings from (1) the reading package and (2) their entrepreneurial experience on three different levels - self, team and entrepreneurship.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Interest in entrepreneurship and sustainability, ability to work in a team

Content:
Supported by the reading package students will work on five intensive days in Campus only in interdisciplinary teams on a challenge from a partner and learn why and how to develop customer and user centric business ideas through applying an entrepreneurial mindset and innovative methods - always considering the triple bottom line.
Taking on an embedded view on the interrelatedness of economic, social and environmental systems, students will develop an ecosystem map to get an overview of relevant stakeholders and potential customers as well as important relationships and value streams. Input on Empathy

Research will prepare them to collect qualitative insights from potential customers and users through interviews, immersion and contextual observations.
After conducting their Empathy Research they will step by step learn how to synthesize their insights and define opportunities for sustainable innovation. With a concrete how-might-we-question they will start into ideation. Through different creativity methods they will develop and prioritize ideas and build a simple prototype. This prototype is being tested again through qualitative tests with potential customers and users. When they come back after testing they do a first iteration based on the feedback they got and derive assumptions on a potential business model. After input on pitching they will prepare slides or other material and pitch in front of the group, partner and external guests. After the pitch event they will be led through a reflection of the learnings they gained during the week. The reading package will support the transfer of these learnings.

Intended Learning Outcomes:
After participating in this module students will be able to understand and apply life-centered design principles in the early stages of an entrepreneurial process: from identifying an entrepreneurial opportunity and understanding its environmental and social impact to validating assumptions by applying qualitative research methods and interpreting data as well as using prototyping as a tool for communication and learning. They will be able to apply creativity methods, take over collective responsibility and know how to effectively communicate their business opportunities.
Taking decisions under uncertainty, ambiguity and risk in newly formed teams will foster their collaboration and communication skills and prepare them for future team work in appreciating and accommodating team members' individual personalities and boundaries.
At the same time the reading package enables students to gain a broader understanding of the methods learned in the course providing them with the ability to apply them beyond the context of innovation.

Teaching and Learning Methods:
This module relies on a combination of readings, input sessions, workshops, teamwork and individual feedback and support. While input sessions will stimulate students’ engagement with relevant tools and topics, workshops and team discussions will support the implementation of the knowledge in their projects and facilitate students’ learning of the soft and intricate aspects of adopting an entrepreneurial mindset and skills. Working on a design challenge that a partner (e.g. TUM Venture Labs) provides stimulates peer competition and allows students to directly apply what they learn in a real life setting. The reading package will strengthen students' understanding of the methods and allow them to make sense of their practical experience.

Media:
Presentations, canvas, handywork

Reading List:
Each semester students will be provided with a mandatory reading package.

Responsible for Module:
Alexy, Oliver; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Innovation Sprint (MGT001348, englisch) (Seminar, 4 SWS)
Alexy O [L], Hartmann B, Baur C
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001404: Scaling Entrepreneurial Ventures | Scaling Entrepreneurial Ventures

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
This module's learning objectives are examined via exercises ("Übungsleistung") comprising the four elements outlined below. There is no written exam.

(1) Individual oral class engagement & homework (40%): For each session, you will be given in advance a set of questions or tasks to prepare (homework). In class, you will be assessed regarding the quality of integrating the prepared homework into course discussions, case assessments, group work, and presentations. This will demonstrate that you can explain and integrate learned entrepreneurial venture scaling and growth concepts, frameworks, and theories in practice and describe, compare, and appraise the conduct and performance of existing scaling/scaled entrepreneurial ventures. In case not all sessions can be attended, under specific circumstances and upon granted instructor permission, you may submit written/video solutions of your homework before class as a basis for grading.

(2) Individual written reflection paper (10%): At the end of the course, you will submit a short reflection paper highlighting the key learnings of the course and explaining why, how, and where they might help you in the future. The individual reflection will show that you can process, synthesize, and prioritize the newly learned knowledge and critically think about and argue for more expansive fields of application beyond those discussed in class.

(3) Group written report (30%): As part of a group composed in the kick-off session, you will create a "scaling plan" by analyzing and formulating the scaling potential and related implications of a real-life early-stage startup and developing concrete recommendations for scaling-related strategies and actions. This assessment will show that you can directly apply the learned frameworks, theories, and concepts to uncover and assess the implications of venture scaling, determine and evaluate suitable scaling strategies, prioritize and initiate actions and decisions for their implementation, identify predictors of failure, and propose mitigative steps. It also illustrates

that you can collaborate in a team, adopt a leader's perspective, strategize, and solve problems in an analytical and structured way. The scaling plan will be submitted at the end of the course. An assessment sheet filled in by each group member and handed in at the end of the course will clarify your individual contribution.

(4) Group final presentation (20%): In the final session, you will present a part of your group's scaling plan. As each member of the group will present, your individual contribution is clearly identifiable and appraisable. The final group presentation will showcase that you are able to synthesize and present your findings in a comprehensive, precise, and structured way. It will also show that you communicate clearly and perform professionally.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Scaling an entrepreneurial venture can be a very complex and demanding challenge. Often this requires a fundamental redesign of many firm areas, high team effort, and very strong leadership. In addition, dynamic markets and grand challenges create additional pressures on young ventures attempting to grow.
This module provides a holistic view of the scaling process of an entrepreneurial venture from a leader's perspective. It introduces you to theories, concepts, and frameworks for scaling entrepreneurial ventures and venture growth. Based on engaging with crucial literature and concepts in entrepreneurship, strategy, and general management, discussing related news articles, case studies, industry insights, and best practices, and applying them in short class activities, you will learn why, how, and when entrepreneurial ventures scale and grow, which challenges and barriers they might face and how to overcome these. In addition, you will use this knowledge to analyze the conduct and performance of existing scaling/entrepreneurial ventures. Finally, you will directly apply this knowledge to assess the scaling potential and related implications of a real-life early-stage tech startup and develop and present concrete recommendations for effective scaling strategies and actions. Thus, the module will prepare you to effectively lead, accompany, or monitor an entrepreneurial venture through its scaling and growth phase.

Topics include, but are not limited to:
- Firm growth and scaling concepts, frameworks, and strategies from theory and practice
- Adopting a growth mindset
- Scaling and sustainability
- Implications of venture scaling: key opportunities and critical challenges focusing on leadership and strategy, people and culture, operations and structure, and financials
- Venture-specific and contextual factors for scaling
- Managerial scaling strategies, decisions, and actions
- Scaling success measures, risks, and risk mitigation strategies

- Venture exit options and strategies
- Predictors of venture failure and steps for dealing with failure and managing a turnaround.

Intended Learning Outcomes:
Upon successful completion of this module, you will be able to:
Knowledge objectives:
(1) Explain and apply key concepts, frameworks, and theories related to scaling entrepreneurial ventures and venture growth in practice
(2) Describe, compare, and appraise the conduct and performance of existing scaling/scaled entrepreneurial ventures
(3) Uncover and assess the implications of venture scaling
(4) Determine and evaluate scaling strategies considering venture-specific and contextual factors
(5) Prioritize and initiate actions and decisions for implementing suitable scaling strategies
(6) Identify predictors of failure and propose mitigative steps

Competencies objectives:
(1) Improve analytical, structured problem-solving, synthesis, and prioritization competencies
(2) Enhance team collaboration and leadership competencies
(3) Strengthen communication, presentation, and argumentation skills
(4) Build up critical thinking and strategizing competencies

Teaching and Learning Methods:
The module consists of an introductory session in which the fundamentals of scaling entrepreneurial ventures and venture growth will be shared and discussed. In addition, groups will be assembled, and each group will select a real-life early-stage tech startup for which a scaling plan will be jointly developed throughout the course.
In subsequent sessions, module contents will be co-developed by the course participants and the instructor(s). To enable building up a solid knowledge fundament, we integrate action-learning elements such as presentations and discussions of course material, case studies, and news articles; flipped classrooms, role plays, and games; and interactions with industry guest speakers. Continuous group work on the scaling plan will ensure that the newly acquired knowledge will be directly applied.
Hence, a large share of learning will occur through your individual and your group’s preparation for the in-class sessions and working on your startup cases. Respective instructions and materials to prepare will be given throughout the course. Through peer review exercises, presentations, discussions of intermediate findings, and feedback provided by the instructor(s), you will be able to share and get an assessment of your progress continuously. The module will end with a group presentation followed by a moderated Q&A and joint reflection exercise.

Media:
Presentations, flipchart, whiteboard, digital tools, videos, Zoom (for feedback sessions)

Reading List:
Specific & mandatory readings will be specified at the beginning of the course.

Familiarizing with the following book is encouraged but not mandatory for passing the course:
- Eisenmann, T. (2021). Why startups fail: A new roadmap for entrepreneurial success. Crown.

Responsible for Module:
Tryba, Anne; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Scaling Entrepreneurial Ventures (MGT001404, englisch) (Limited places) (Seminar, 4 SWS)
Tryba A [L], Mayer C, Tacke F
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001405: Global entrepreneurship summer school | Global entrepreneurship summer school

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The final examination of the project consists of two components. The first is the presentation prepared by the students at the end of the summer school. The second part is a final report that must be submitted approximately eight weeks after the summer school. Both count for 50% of the grade.

At the final event of the summer school, the teams present an approach to solving the problem challenge they have worked on in the field of climate change. The presentation has a length of 5-10 minutes and is evaluated by an external jury. The students thus demonstrate that they are able to transform the information they have received into the independent development of an impact-oriented business model and present it appropriately. In the preparation of the presentation, they are accompanied and supported by their coaches and the accompanying facilitators.

The second part of the grade consists in the report to be submitted after the summer school. It documents in a structured way how the information received was used to develop an impact-oriented business model. Furthermore, feedback received during the final presentation should be considered and incorporated. The report ensures that instead of simply documenting their findings students structure and reflect on them. The final report should not exceed 7500 characters and must be submitted eight weeks after the completion of the summer school.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
- Basic understanding of entrepreneurship and its principles, such as from attending an introductory lecture on the topic, founding experience, or closely following the media on the topic

- Interest in developing innovative solutions from a systemic perspective to generate social and environmental impact

Content:
As part of the Global Entrepreneurship Summer School (GESS), up to 50 international students from universities all over the world per cohort spend seven days intensively working on global challenges and the question of how these can be solved with the help of social and innovative business ideas. In preparation, the participants learn about the forms and goals of Social Entrepreneurship with online materials. Furthermore, they inform themselves and reflect on the effects of climate change in their local context. For this purpose, they interview two to three people and showcase and share their observations and information in the provided online workspace.

During the actual Summer School in Munich and, possibly, at other locations in parallel, they discuss and research current problems in the field of climate change and then develop entrepreneurial ideas for solutions. To support them, methods and knowledge are conveyed on topics such as system innovation, design thinking, business modeling, impact management and financing. The systemic perspective is of particular importance in the program. "Wicked problems" as represented by the social and ecological problems of our time cannot be solved in isolation. Solutions are therefore only possible by looking at them as phenomena inside of complex systems.

At the end of the Summer School, the students present the solutions they have developed in the form of impact-oriented business models to a jury and guests. In this context, they receive feedback and the opportunity to apply for follow-up coaching for the business ideas they have developed. The final report reflects on the process and structures its results.

Intended Learning Outcomes:
The GESS aims to enable students to develop practice-oriented approaches to solutions in the form of impact-oriented business models. The aim is to generate impact in the sense of the United Nations Sustainable Development Goals. The students learn:

- to understand and apply the concept of impact and its implications
- to implement the entrepreneurial innovation process in interdisciplinary teams to generate concrete solutions
- to apply tools and methods from the field of system innovation and human-centered design.

The GESS focuses on experiential and problem-based learning and aims both to advance the development of social and entrepreneurial innovation and to promote and develop students' skills in responsible entrepreneurship. By working on solutions in international teams, students also improve soft skills such as creativity, perseverance, communication skills, and intercultural competencies.

Teaching and Learning Methods:
Lectures, discussion, development of challenges, excursion, team coaching sessions, feedback discussion, presentation, Q&A session. The variety of methods ensures that the right method is chosen for each learning content to be conveyed. For example, new knowledge and tools are presented by experts in impulse lectures and then discussed in large or small groups before they are incorporated into the development of solutions. Feedback talks and team coaching sessions guarantee that the tools and methods presented are correctly understood and applied. Furthermore, good cooperation within the teams is ensured and an appreciative feedback culture is trained. The final presentation at the closing event gives the participants the opportunity to practise their communication skills. The final report helps to consolidate and reflect on the acquired knowledge.

Media:
Videos, presentations, online materials, quiz, exercise sheets, Power Point, flip charts, mural boards

Reading List:
Thinking in Systems, Donella Meadows. Earthscan, 2009
Martin, L. Design of Business: Why Design Thinking is the Next Competitive Advantage. Harvard Business Press, 2009
Kurz, B./ Kubek, D.: Social Impact Navigator, Phineo, 2017, verfügbar auf https://www.social-impact-navigator.org/

Responsible for Module:
Alexy, Oliver; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Global Entrepreneurship Summer School (MGT001405, englisch) (Seminar, 4 SWS)
Alexy O (Vogel C)
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001410: ChangeMakers: Entrepreneurial and Design Competencies for Societal Transformation | ChangeMakers: Entrepreneurial and Design Competencies for Societal Transformation

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
This module's learning objectives are examined via exercises (“Übungsleistung”) comprising the three elements outlined below. There is no written exam.

(1) Group final presentation (50%): In the final session, you will present your team's approach and solution for a societally relevant challenge identified at the beginning of the course. The presentation format can be chosen by your team and should include the presentation of a design artifact. Design artifacts can include a 3-dimensional object, a visual representation, a video, a storyline, a systems map, and many other forms of storytelling and visualization. Presentations will last approximately 5 minutes, followed by a 5-10 minute Q&A and feedback round. Each team member must actively participate so your individual contribution is identifiable and appraisable. The final group presentation will showcase that you have acquired and can demonstrate essential entrepreneurial and design competencies: focus – you can identify whether a problem is worth solving; courage – you understand your role in creating change; imagination – you are capable of developing and articulating a vision; and action – you know how to take next steps.

(2) Individually written reflection paper (20%): At the end of the course, you will submit a short paper (2 pages excl. sources) reflecting on
(a) your overall experience with and synthesis of the course's format (considering both the experiential learning immersion and the reading package)
(b) your critical reflection on the design solution you and your team created
(c) whether and how the course allows and will allow you to generate hope in the face of critical societal challenges

(3) Daily course exercises (30%)

In each session during the project week, you will be asked to submit a small reflection exercise related to the day's content and learning objectives via Moodle. We will dedicate 10-15 minutes of each session to this exercise using a set of questions. You will be guided through the exercise by the course instructors. This will demonstrate that you have engaged with, understood, and critically reflected on the day's topic.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fluency in English; interest in entrepreneurship, design, and a sustainable future; willingness to work in a team;

Due to the nature of the assessments and the ongoing team-based work in this course, consistent participation is mandatory. If you need to miss a session for health reasons or other valid circumstances, please inform us in advance via email. We may provide an opportunity to make up the missed material or, in cases of documented illness, assign a "Q" grade (indicating a missed exam with an accepted medical certificate).

Please note: Conflicts such as overlapping courses or work commitments are considered planning issues and should be resolved before enrolling in the course.

Content:
In this module, students will acquire entrepreneurial and design competencies through experiential and scenario-based learning: Set in a future scenario, students will be confronted with signals (based on scientific projections) that make clear what circumstances we may live in in the future. The Impulse Symposium ahead of the project week will provide inspiration and insight to stimulate students' imagination of the future we might live in. During the immersive project week, participants will work in small teams to create a real-life practical solution for a larger societal problem: The first day of the project week creates space to explore what challenges students find relevant and care about, and to explore through design and entrepreneurial methods whether these challenges appear to be worth solving. Throughout the week, students will learn and apply creative problem-solving methods, entrepreneurial thinking and decision-making to work through that challenge they chose. Students will be encouraged to leverage Generative AI tools to illustrate the ideas they create. Students will be guided to apply visualization and prototyping methods as well as reflection techniques that will support them in producing a shareable vision of a livable and lovable future and identify why and how they can contribute to realizing it.
The module is intentionally structured to include an impulse before, as well as iteration and reflection after an immersive project week. In addition, students will receive a reading package. Combining these elements will allow students to start well-prepared, reactive their prior knowledge, inform themselves about relevant methods, and process and appraise new information.

Intended Learning Outcomes:
After successful completion of this module, students will be able to:

● Understand and apply basic entrepreneurial and design competencies, including: Focus for sophisticated problem identification; Courage to take an active role in creating change; Imagination to develop and articulate ideas; Action to take an idea forward towards implementation
● Leverage these competencies to retain hope in the face of critical societal challenges

While developing and articulating solutions in interdisciplinary project teams, students will learn how to plan, manage and conduct a project, mobilize scarce resources, act in the face of uncertainty, collaborate in a team, and present, discuss, and reflect upon their own solutions convincingly. In addition, working with future scenarios will strengthen students' creative confidence and analytical and strategic skills.

Teaching and Learning Methods:
This module relies on six core elements:

● Impulse – a university-wide public mini-symposium that includes high-quality inspirational speakers who will set the tone and give context.
● Project Week – an immersive one-week project-based experience including theory-driven and methodological impulses, team activities, interactive discussions, flipped classroom elements, and guided project work inside and outside the classroom.
● Iteration – a review of the work that has been created during the project week in small teams accompanied by feedback and support from peers and subsequent further development.
● Presentation – a celebratory moment where participating teams share their work with each other and discuss their process and results.
● Reflection – a moment to reflect on the experience and, importantly, plan for possible next steps of integrating the newly acquired skills into one’s work.
● Reading package - a collection of supporting course material, links, and articles to strengthen the understanding and sensemaking of the applied methods.

Media:
Presentations, videos, flipchart, whiteboard, digital tools, Zoom for feedback sessions, prototyping materials

Reading List:
Each semester students will be provided with a reading list relevant to the course.
Inspirational readings include (students will be asked to engage with a selection of inspirational readings):
*Arend, R. J. (2020). The roles of thought and affect on entrepreneurship – A new hope. Journal of Business Venturing Insights, 14. DOI: 10.1016/j.jbvi.2020.e00188.
* Brown, T., Carey, S.,& Wyatt, J.(2021). The next chapter in design for social innovation. Stanford Social Innovation Review.
* Giudice, M., & Ireland, C. (2023). Changemakers: How leaders can design change in an insanely complex world. Two Waves Books.

* Hari, J. (2023). Stolen focus: Why you can't pay attention--and how to think deeply again. Crown.
* Holiday, R. (2021). Courage is calling: Fortune favors the brave. Penguin.
* Hoppe, M., & Namdar, K. (2023). Towards entrepreneurship for a cause: educating transformative entrepreneurial selves for a better world. Entrepreneurship Education and Pedagogy, 6(4), 590-607.
*. Lans, T., Blok, V., & Wesselink, R. (2014). Learning apart and together: towards an integrated competence framework for sustainable entrepreneurship in higher education. Journal of Cleaner Production, 62, 37-47.
* Markovitz, D. (2020). How to avoid rushing to solutions when problem-solving. Harvard Business Review Digital Articles, 2–6.
* Mauch, C. (2019). Slow hope: Rethinking ecologies of crisis and fear. RCC Perspectives: Transformations in Environment and Society, 1. doi.org/10.5282/rcc/8556.
* Noel, L. A. (2023). Design social change: Take action, work toward equity, and challenge the status quo. Ten Speed Press.
* Thackara, J. (2005): In the Bubble: Designing in a complex world; The MIT Press.
* Wedell-Wedellsborg, T. (2017). Are you solving the right problems? Harvard Business Review, 95(1), 76–83.
* Weiss, L. (2017). Stop mindlessly going through your work day. Harvard Business Review Digital Articles, 2–4.

Responsible for Module:
Tryba, Anne; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
ChangeMakers: Entrepreneurial and Design Competencies for Societal Transformation (MGT001410, englisch) (Seminar, 4 SWS)
Tryba A, Diefenthaler A, Löhe T, Mayer C
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001435: Impact Entrepreneurship for Transformational Change | Impact Entrepreneurship for Transformational Change

Version of module description: Gültig ab winterterm 2025/26

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

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

Description of Examination Method:
The examination consists of two components. In the accompanying online course, the content of the respective units is tested and deepened through reflection tasks and research tasks (approximately 18,000 signs including spaces). This part represents 50% of the grade. Furthermore, the presentation prepared by the students at the end of the semester and its corresponding documentation (pitch deck or similar) is part of the examination (50%).

As part of a final event, the teams present a solution idea for the problem they have chosen and developed in the area of society, ecology or technology. The presentation lasts 5-10 minutes. The students demonstrate that they are able to translate the information they have received into an independently developed impact-orientated business model and present this in an appropriate manner. They are supported in their preparation by regular feedback from lecturers and coaches.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
- Basic understanding of entrepreneurship and its principles, such as from attending an introductory lecture on the topic, founding experience, or closely following the media on the topic
- Basic knowledge in sustainability
- Interest in developing innovative solutions from a systemic perspective to generate social and environmental impact

Content:
As part of the course, students from various disciplines spend a semester working intensively on social, ecological or technological challenges and the question of how these can be solved with the help of social and innovative business ideas.

The programme teaches methods and knowledge on topics such as system innovation, design thinking, future thinking, regenerative and impact-oriented business models, impact management and financing. The systemic perspective is of particular importance in the programme. In particular, the major social and ecological problems of our time cannot be solved in isolation as "wicked problems". Solutions are therefore only possible by viewing them as phenomena that are integrated into systems.

Students work in teams on social, ecological or technological challenges and apply the methodological knowledge they have acquired to develop an entrepreneurial solution for the selected problem. This process is structured and supported by lecturers and external coaches.

At the end of the semester, the students present the solutions they have developed in the form of impact-orientated business models. In this context, they receive feedback and the opportunity to apply for follow-up coaching for the business ideas they have developed.

The course is held in German in the summer semester and in English in the winter semester.

Intended Learning Outcomes:
The aim of the module is to enable students to develop practice-oriented solutions in the form of impact-oriented business models. The focus is on generating impact in the sense of the United Nations Sustainable Development Goals. Students will be able to

- explain the concept of impact and its implications and illustrate them using specific case studies.
- develop entrepreneurial solutions for real challenges in interdisciplinary teams.
- apply tools and methods from the fields of systems thinking, future thinking, human-centred design, impact orientation and business modelling to their challenges.
- present the solutions developed for their challenges using professional presentation techniques appropriate to the target group.
- categorise and discuss alternative economic models such as the Economy for the Common Good, Doughnut Economics and post-growth approaches.

The module focuses on experience-based and problem-oriented learning and aims to promote the development of social and entrepreneurial innovations as well as the promotion and development of students' skills with regard to responsible entrepreneurship. By developing solutions in interdisciplinary teams, students also improve their soft skills such as creativity, perseverance, communication skills, and interdisciplinary competences.

Teaching and Learning Methods:
Lectures and interactive, seminar-style teaching in the form of discussions, group work, development of challenges, team coaching sessions, feedback discussions, presentations, and Q&A sessions. The variety of methods ensures that the right method is chosen for each learning content to be taught. For example, new knowledge and tools are presented by experts in the field in keynote speeches and then discussed in large or small groups before being incorporated

into the development of solutions. Feedback discussions and team coaching sessions facilitate the application of the tools and methods presented. The final presentation at the closing event gives participants the opportunity to practise their communication skills and improve them through appreciative, constructive feedback. The synchronous online and face-to-face teaching is supplemented by asynchronous elements of self-learning time via the accompanying online course and associated reflection tasks, as well as by self-organised project group meetings, which are documented in the final report.

Media:
Videos, presentations, online materials, quiz, exercise sheets, Power Point, flip charts, mural boards

Reading List:
Meadows, Donella: Thinking in Systems, Earthscan, 2009
Stroh, David Peter: Systems Thinking For Social Change: A Practical Guide to Solving Complex Problems, Chelsea Green Publishing, 2015
Kurz, B./ Kubek, D.: Social Impact Navigator, Phineo, 2017, verfügbar auf https://www.social-impact-navigator.org/

Responsible for Module:
Alexy, Oliver; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Impact Entrepreneurship for Transformational Change (MGT001435, deutsch) (Seminar, 4 SWS)
Alexy O [L], Alexy O (Kaoui V, Vogel C)
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001459: TUM Climate Ventures | TUM Climate Ventures

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 135	**Contact Hours:** 45

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

Description of Examination Method:
This module's learning objectives are examined via exercises (“Übungsleistung”) comprising the three elements outlined below. There is no written exam.

(1) Individual written reflection paper (10%): At the end of each session, you will submit a short reflection paper of 1/2 page (font size 12; double line spacing) highlighting the key learnings of the course and explaining why, how, and where they might influence your project. The individual reflection will show that you can process, synthesize, and prioritize the newly learned knowledge and critically think about and argue for more expansive fields of application beyond those discussed in class.

(2) Group presentations (60%): During the class, there will be three presentations: (1) A pitch in the first weeks of the course (2 minutes), (2) a midterm pitch (10 minutes), and (3) a final pitch (15 minutes). Each pitch has to reflect the content of the course. In the session, you will present a part of your group's climate venture. As each member of the group will present, your individual contribution is clearly identifiable and appraisable. The final group presentation will showcase that you are able to synthesize and present your findings in a comprehensive, precise, and structured way. It will also show that you communicate clearly and perform professionally. The final pitch will be graded.

(3) Group written reporting (30%): As part of a group composed in the first two weeks of the course, you will work on a climate venture project by assessing, analyzing, and designing climate-tech venture related strategies and actions. This assessment will show that you can directly apply the learned frameworks, theories, and concepts to uncover and assess the implications of climate ventures, determine and evaluate suitable climate ventures strategies, prioritize and initiate actions and decisions for their implementation, identify predictors of failure, and propose mitigative steps. It also illustrates that you can collaborate in a team, adopt a leader's perspective, strategize,

and solve problems in an analytical and structured way. The reporting includes the submission of a weekly (1) agenda for office hours meetings, a weekly update of an (2) interview tracking spreadsheet (approximately 50 interviews with experts and potential customers that you will conduct between week 3-13), and (3) the pitch decks of your presentations. An assessment sheet filled in by each group member and handed in at the end of the course will clarify your individual contribution.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The course is looking for two different skill sets. You should either have advanced entrepreneurial knowledge and experience through courses, practical experience, or advanced programs like Manage&More or CDTM, or you have advanced technological understanding of relevant climate tech applications.

Content:
Building climate ventures that have impact can be a very complex and demanding challenge. Often this requires an expanded skillset of how to identify, assess, analyze, design, build, and launch climate-tech ventures, as well as high team effort, and very strong leadership. In addition, dynamic markets, technological uncertainties and grand challenges create additional pressures on novel ventures understanding their impact. This module provides a holistic view of the climate venture process in a real-world project. It introduces you to theories, concepts, and frameworks for climate ventures. Students will gain hands-on experience in the startup process, learning how to identify, assess, analyze, design, build, and launch climate-tech ventures.

Emphasis will be placed on effective collaboration within interdisciplinary teams to tackle real-world climate challenges. The course will help students build a strong climate-tech network and community, providing opportunities for collaboration and support. Students will work on creating new companies aimed at addressing high-impact climate problems, from ideation to market entry.

Exploration of breakthrough technologies and their potential applications in solving global climate issues will be a key component of the course. Students will understand the fundamentals of economic and technical evaluations specific to the climate-tech industry. The course will teach customer-centric approaches to developing climate solutions, emphasizing the importance of understanding and addressing customer needs.

Navigating the regulatory and market landscapes influencing climate-tech ventures will also be covered, helping students understand the broader context of their projects.

Intended Learning Outcomes:
Upon successful completion of this module, you will be able to:
Course Learning Goals:

1. Analyze relevant technical, business, political, and social drivers and barriers behind a vexing climate-tech challenge and design a solution as a team to address it.
2. Synthesize insights from research, analysis, and external engagements to compose a compelling value proposition around a new venture.
3. Evaluate and iterate through the potential success of a venture plan that meets the criteria of high impact, white space, unique value proposition, and self-sustainability.

Knowledge objectives:
(1) Explain and apply key concepts, frameworks, and theories related to climate ventures in practice
(2) Uncover and assess the implications of relevant technical, business, political, and environmental drivers and barriers behind climate tech ventures
(3) Determine and evaluate climate venture strategies considering venture-specific and contextual factors through research and external feedback
(4) Prioritize and initiate actions and decisions for implementing climate tech ventures with impact
(5) Identify predictors of failure and propose mitigative steps
Competencies objectives:
(1) Improve analytical, structured problem-solving, synthesis, and prioritization competencies
(2) Enhance team collaboration and leadership competencies
(3) Strengthen communication, presentation, and argumentation skills
(4) Build up critical thinking and strategizing competencies
(5) Perform under a maximised degree of realism in building a venture

Teaching and Learning Methods:
The module consists of an introductory session in which the fundamentals of climate ventures will be shared and discussed. In addition, groups will be matched and assembled, and each group will work on a real-world climate-tech venture for which a business case will be jointly developed throughout the course.

In subsequent sessions, module contents will be co-developed by the course participants, the instructor(s), and guest lecturers. To enable building up a solid knowledge fundament, we integrate action-learning elements such as presentations and discussions of course material, interview results, and relevant publications; individual mentoring; and interactions with industry and venture capital guest speakers.

Continuous mentoring on the climate-tech ventures will ensure that the newly acquired knowledge will be directly applied. Groups are asked to gather information on their climate venture cases through approximately 50 interviews.
Hence, a large share of learning will occur through your individual and your group’s preparation for the in-class sessions and working on your climate venture projects. Respective instructions and materials to prepare will be given throughout the course.

Through presentations, discussions of intermediate findings, guest lectures, and feedback provided by the instructor(s), mentors, industry experts and venture capitalists, you will be able to share and get an assessment of your progress continuously. The module will end with a group presentation followed by a moderated Q&A and joint reflection exercise.

Media:
Presentations, flipchart, whiteboard, digital tools, videos, Zoom (for feedback sessions)

Reading List:
Class materials, lecture slides, suggested readings, other materials recommended for each team and guest speaker slides will be posted on Moodle.

Responsible for Module:
Tryba, Anne; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
TUM Climate Ventures (MGT001459, englisch) (Seminar, 4 SWS)
Tryba A [L], Eiermann-Hüser L, Lara Vargas L, Reiter S, Viertler M
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001486: Smart Start: Financial, Tax, and Legal Fundamentals for Entrepreneurs and Everyone | Smart Start: Financial, Tax, and Legal Fundamentals for Entrepreneurs and Everyone

Version of module description: Gültig ab winterterm 2025/26

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

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

Description of Examination Method:
As an examination requirement, participants will choose a topic, study it in depth and prepare it in a didactic manner so that all other course participants can also benefit from it. During the seminar, they will have the opportunity to present and discuss this topic and receive feedback on the content they have developed following the presentation and as part of a peer review process. Building on this, participants will further develop, concretise and clearly present their topic over the course of the semester.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
none

Content:
This hands-on seminar equips (potential) entrepreneurs with essential financial, tax, and legal knowledge needed for long-term success. Participants will gain a deep understanding of core topics, empowering them to make informed decisions about legal structures, tax optimization, and financial planning. By the end, attendees will have developed a personalized Smart Start Master Plan

Intended Learning Outcomes:
Acquisition of sound knowledge in the areas of financial planning, tax law and the legal framework for entrepreneurial activity.

Ability to make well-founded decisions on the choice of legal form, tax optimization and long-term financial strategy.

Development of an individual Smart Start Master Plan for the concrete implementation of your own start-up idea.

Consolidation of knowledge through practice-oriented methods such as exercises, role plays, presentations and discussions.

Teaching and Learning Methods:
During the seminar, participants will receive input on the topics covered in seminar, as well as working materials for self-study and review. The content will then be consolidated in the seminar through exercises, role plays, reflections, presentations and discussions.

Media:
PowerPoint

Reading List:
Keck, A. (2022). GmbH gründen: Alles, was du wissen musst – Eine Schritt-für-Schritt-Anleitung zur Gründung einer GmbH oder UG (Steuern sparen, GmbH & Holding richtig nutzen). Unternehmergold Verlag.
Backhaus, R. (2022). Vererben und Erben. Stiftung Warentest Finanztest.
Kommer, G., & Gierhake, O. (2021). Souverän Vermögen schützen: Wie sich Vermögende gegen Risiken absichern – ein praktischer Asset-Protection-Ratgeber (1. Aufl.). Campus Verlag
Keck. A. (2021). Weniger Steuern & mehr Vermögen: Wie du als Unternehmer*in mehr aus deinem Geld machst – Rechtsform, Holding, Gehalt, Investitionen und Altersvorsorge (Steuern sparen, GmbH & Holding richtig nutzen). Unternehmergold Verlag.
Siegel, J. (2022). Stocks for the Long Run: The Definitive Guide to Financial Market Returns & Long-Term Investment Strategies. McGraw Hill.
Graham, B. (2003). The Intelligent Investor. Harper Business.
Kahnemann, D. (2016). Thinking, Fast and Slow. Penguin Verlag.
Shefrin, H. (2007). Beyond Greed and Fear: Understanding Behavioral Finance and the Psychology of Investing. Oxford University Press, U.S.A.
Kiyosaki, R. (2022). Rich Dad Poor Dad: What the Rich Teach Their Kids About Money That the Poor and Middle Class Do Not! Plata Publishing
Kommer, G. (2018). Souverän investieren für Einsteiger: Wie Sie mit ETFs ein Vermögen bilden. Campus Verlag GmbH.
Kommer, G. (2024). Souverän investieren mit Indexfonds und ETFs. Campus Verlag GmbH.
Kehl, T., Linke, M. (2022). Das einzige Buch, das Du über Finanzen lesen solltest: Der entspannte Weg zum Vermögen. Ullstein Taschenbuchvlg.
Walz, H. (2023). Ihre Finanzen fest im Griff: Vermögen aufbauen, statt Geld verschenken. Haufe.

Responsible for Module:
Welpe, Isabell M.; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Smart Start: Financial, Tax, and Legal Fundamentals for Entrepreneurs and Everyone (MGT001486, englisch) (Limited places) (Seminar, 4 SWS)
Hochstraßer S, Welpe I, Wimmer C
For further information in this module, please click campus.tum.de or here.

Module Description

SOT82134: Business Negotiation and Mediation | Business Negotiation and Mediation

Version of module description: Gültig ab summerterm 2025

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

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

Description of Examination Method:
The module examination is a presentation (30 minutes, including 20 minutes presentation and 10 minutes discussion). The topic of the presentation covers one of the topics covered in the module or related topics. The module examination can also be taken by participating in and presenting a comprehensive case study as part of the seminar. In the various units, the principles of negotiation theory and business mediation are developed and presented together with the students. The plan is for students to build on this by comprehensively presenting a specific problem area from the introduction. In particular, structural perspective issues should be presented with a view to the strategic, psychological, and economic problem areas of negotiation theory as well as the relevant processes of complex business mediation. By preparing the presentation or case study, students demonstrate that they have understood the various dimensions of negotiation theory and business mediation and have gained in-depth knowledge of the issues presented. In the discussion part, they will show that they are able to recognize the connections between the respective introductory parts.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None.
No prior legal or technical knowledge is required. Everything that is necessary for attending and passing the module is taught as part of the module. Preparation before the start of the module is also not necessary.

Content:
At the beginning of the module, there will be an introduction to the topic of negotiation theory, focusing in particular on the central importance of negotiations in the economic and political spheres and discussing common negotiation goals and levels. The main types of conflict in an economic context will be presented and the psychological aspects of negotiation theory will be highlighted. This is followed by an introduction to negotiation theories, distinguishing between distributive and integrative negotiation. Various negotiation styles and communication techniques are then presented and discussed. Finally, important strategic aspects of negotiation are introduced. The various topics of the seminar are accompanied by a range of case studies and interactive negotiation simulations.
In a second step, students are introduced to the concept of business mediation as a form of conflict management, with a particular focus on the organizational process of a mediation procedure. Students will learn to develop creative solutions to underlying economic problems using innovative visualization and communication techniques. In particular, connections will be made to the principles of negotiation theory taught earlier.
The module ends with a comprehensive case study in which students are assigned the role of business mediator or party to the dispute and are asked to demonstrate the knowledge and skills they have learned in the seminar. The negotiation simulation will be supervised and then comprehensively analyzed and discussed.

Intended Learning Outcomes:
Upon completion of the module, students will be able to describe the fundamentals of negotiation theory and will be familiar with the relevant concepts of strategic negotiation, the psychological and economic background, and the basic communication techniques of successful business-related negotiation. In addition, students will gain in-depth knowledge of the process, methods, and implementation of business mediation, learning in particular about the various paths to mediation, the fundamentals of procedural law, processes, visualization techniques, and solution techniques. The aim is, in particular, to enable students to understand the breadth of the topic of negotiation management and business mediation and how the topic extends across various economic and political areas.

Teaching and Learning Methods:
The module is conducted as a seminar in the form of theory sections/lectures combined with discussion sections and case studies. It is an interactive block seminar divided into four sessions, each of which differs methodologically from the others. In each session, the basic knowledge required for the seminar is first imparted through lectures with discussion elements. In addition, students have the opportunity to work on specific case studies under supervision and guidance, discussing them with each other and asking the lecturer questions. The last session consists of a final, comprehensive case study, followed by a comprehensive final discussion in which the results are compared and abstracted.

Media:
PowerPoint

Reading List:
The following literature can be read in preparation but is by no means a prerequisite. In particular, nothing needs to be purchased:
- R. Fisher/W. Ury/B. Patton, Getting to Yes, 2012
- R. Fisher/W. Ury/B. Patton, The Harvard Concept, 2018
- S. Jung/P. Krebs, Die Vertragsverhandlung, 2016
- T. Schelling, The Strategy of Conflict, 1960
- D. Ariely, Predictably Irrational, 2008
- G. Williams, Legal Negotiation and Settlement, 1983
- F. De Calliers, L'art de negotier sous Lous XIV, 1761 (engl.: The Art of Diplomacy. On the manner of negotiating with princes.)

Responsible for Module:
Paal, Boris; Prof. Prof. Dr. Dr. jur.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT82134) Business Negotiation and Mediation (Seminar, 2 SWS)
Djebbari S, Paal B (Krikis K)
For further information in this module, please click campus.tum.de or here.

Module Description

SOT82410: Legal framework for start-ups | Rechtliche Grundlagen für Start-ups

Version of module description: Gültig ab summerterm 2025

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

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

Description of Examination Method:
The module examination is a written examination.
The written examination covers topics relating to the legal framework for creating a start-up. The exam lasts 60 minutes and consists of several questions in which students demonstrate that they have understood the essential legal regulations of industrial property rights, product labeling, data protection law and competition law. In addition, the exam is intended to show that students have understood the concept of founding a start-up and can identify the criteria for selecting a suitable legal form and financing for the start-up. Through the written examination, students demonstrate that they can present the individual analysis and decision-making steps in a comprehensible and coherent manner in a suitable written form.

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
The following topics are covered in the module:
Founding a start-up: legal form and tax law, financing and contracts, specifics, etc.;
Protection of Intellectual Property: Intellectual Property, Patents, Copyright, Trade Secrets, Trademarks;
Data protection law;
Competition law

Intended Learning Outcomes:
After completing the seminar, students will be able to choose the appropriate legal form for the establishment of a start-up, as well as to identify the appropriate financing method for the foundation. In addition, students are able to understand the essential legal regulations of intellectual property law, product labelling, data protection law and competition law.

Teaching and Learning Methods:
The module will be conducted as a seminar in the form of business games / case studies. The students will first complete several introductory units that explain the course of the business game. Subsequently, the students will create concepts for the foundation of a start-up in groups and carry out legal analyses. Finally, qualified feedback is given to show the students possible improvements.

Media:
Exercise documents, PowerPoint, Reader

Reading List:
1. "Wirtschaftsrecht: Handels- und Gesellschaftsrecht", 2. Auflage; Kristian Ewers, Sebastian Jagusch, Daniel Lorberg; NWB Verlag; ISBN: 978-3-470-65542-0
2. "Steuerrecht – leicht gemacht: Eine Einführung nicht nur für Studierende an Universitäten, Hochschulen und Berufsakademien"; 6. Auflage; Stephan Kudert; Ewald-von-Kleist-Verlag; ISBN: 978-3-874-40330-6
3. "Gewerblicher Rechtsschutz und Urheberrecht"; 13. Auflage; Joachim Gruber; Niederle, J; ISBN: 978-3-867-24131-1

Responsible for Module:
Paal, Boris; Prof. Prof. Dr. Dr. jur.

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

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

Module Description

WI001141: Principled Entrepreneurial Decisions | Principled Entrepreneurial Decisions [PED]

How to make game-changing decisions

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 140	**Contact Hours:** 40

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

Description of Examination Method:
Mandatory participation on all workshop days
(1) active class participation (25%)
(2) short assignement questions on cases (25%)
(3) presentation of values and principles for their company/project/future startup (25%)
(4) reflection paper, 2-3 pages, max 1.200 words (25%)
The seminar is on application:
https://academy.unternehmertum.de/programs/principled-entrepreneurial-decisions

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Application & willingness for active participation
being or becoming part of a Startup or project team
Students who are interested in Venture Capital and decision-making of founders are also welcome

Content:
This course will challenge the next generation of leaders and entrepreneurs to think critically about how their personal values and principles inform the difficult decisions they will have to make as they grow their business. The course will first equip students with frameworks to crystalize their own values and principles. Students will learn to apply their own core values. A selection of readings and case studies will provide students with tangible examples of the challenges other entrepreneurs have faced. Each class will be highly immersive, featuring conversations with entrepreneurial guest speakers and break-out sessions. Through conversations with case

protagonists and each other, students will leave the class more prepared to navigate the ethical dilemmas that they may encounter during their professional lives.

Intended Learning Outcomes:
1_students are able to brave difficult situations in the startup context
2_Enable students to begin to craft their own framework – personal and company
3_Discuss case examples (i.e. Flixbus, Konux, ProGlove, Luminovo, fernride, Reactive Robotics, Grupon, buecher.de, SevDesk, inveox, 10X, ...) and conduct exercises to help them on their journey

Teaching and Learning Methods:
lectures
group works
role plays
real Start-up cases with the founders in class
discussions

Media:
presentations
founders in class
video

Reading List:
Dalio, R. (2017). Principles: Life and work. New York, NY
Horowitz, B., & Kenerly, K. (2014). The hard thing about hard things: building a business when there are no easy answers. New York, NY: Harper Business.
More literature will be provided in class

Responsible for Module:
Patzelt, Holger; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Principled Entrepreneurial Decisions (WI001141, englisch) (Seminar, 4 SWS)
Bücken O
For further information in this module, please click campus.tum.de or here.

Module Description

MCTS0041: Advanced Topic: Ethics & Responsibility | Advanced Topic: Ethics & Responsibility

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 120	**Contact Hours:** 30

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

Description of Examination Method:
Students are required to write a research paper (2300 - 2500 words) in which they demonstrate their ability to:
- understand and analyze ethical concepts of reasoning, their opportunities and limitations, from a theoretical and practical point of view
- identify ethical conflicts in the context of technology and society
- apply a specific ethical position to an empirical example
- design their own research approach
The paper is accompanied by a graded presentation (20 - 30 minutes) in which students demonstrate their ability to present their findings in a clear and concise manner. The weighting of the grades is 70% for the paper and 30% for the presentation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should, ideally, have basic knowledge in this field of STS. An Advanced Topic module either constitutes a content-specific specialization of the corresponding Core Topic module or it allows students to apply the concepts and theories learned in the corresponding Core Topic module to their own research questions. Students who have not taken the corresponding Core Topic module are provided with a preparatory reading list.

Content:
This module introduces students to the following topics:
- different fields of applied ethics in the science of technologies, their special questions, problems, and strategies of ethical problem-solving

- different case studies and how they reflect ethical conflicts in fields of techno-sciences and society
- the ethical validation of case studies in Science and Technology Studies (STS)
- strategies for ethical problem-solving in special fields of applied sciences and technology
- ways of designing research approaches in the field of applied ethics

Intended Learning Outcomes:
Upon successful completion of this module, students are able to:
- analyze different ethical concepts of reasoning, their opportunities and limitations, from a theoretical and practical point of view,
- identify specific ethical conflicts in different fields of techno-sciences and society, e.g. technological innovation vs. ethical acceptance in society (e.g. genetic engineering)
- evaluate these conflicts and apply them to concrete practical examples, e.g. social media, big data, and the private sphere
- develop a specific strategy of problem-solving by working on an empirical case study
- design their own research approach that could be applied in a master's thesis
- present their findings in a clear and concise manner

Teaching and Learning Methods:
Studying advanced literature familiarizes students with the different ethical concepts of reasoning. Discussing case studies, key texts and other sources trains students to structure their knowledge, evaluate relevant issues and ethical conflicts caused by technological development, and to develop strategies of problem-solving and research approaches. Presenting and discussing their work trains students in structuring their arguments in a concise manner and defending their own findings and positions in academic debate.

Media:
Texts, slide presentations, flipchart/whiteboard, worksheets, Moodle

Reading List:
Fleming, John I. (et al.), Ethics of Risk. Southern Cross Bioethics Institute, Ratio 6 (1) June 1993. pp 239-252; http://www.bioethics.org.au/Resources/Online%20Articles/Other%20Articles/The%20ethics%20of%20risk.pdf).

Grunwald, Armin: Technology Assessment or Ethics of Technology?, Reflections on Technology Development between Social Sciences and Philosophy, Ethical Perspectives 6 (1999)2, pp. 171-182 (http://www.ethical-perspectives.be/viewpic.php?LAN=E&TABLE=EP&ID=237).

Hedgecoe, Adam M.: Critical bioethics: beyond the social science critique of applied ethics. Bioethics 18.2 (2004): 120-143.

John J. Reilly Center (Eds.): The Reilly Center Reports. Ethics and policy in pace with science and technology, Notre Dame 2013, http://reilly.nd.edu/rcr.

van den Hoven, J. (et al.) (Eds.): Responsible Research and Innovation Actions in Science Education, Gender and Ethics. Cases and Experiences, New York Springer 2014.Please specify 5-8 books or articles.

Plus additional literature specified at the beginning of the course

Responsible for Module:
Leonelli, Sabina; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Ethics & Responsibility: Society, Technology and Environment (Seminar, 2 SWS)
Jones E

Decision-Making Systems (Seminar, 4 SWS)
Milano S
For further information in this module, please click campus.tum.de or here.

Module Description

SOT53200: Responsibility in the Engineering Profession | Verantwortung im Ingenieurberuf

Applied Ethics for Engineers

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The examination consists of of a presentation (15 - 20 minutes) and an essay (1000 - 1200 words) in which the students demonstrate their analytical-argumentative abilities:
- to identify different conflicting goals of their profession, which are elaborated in the course, with regard to functional, social-normative and ethical implications and classify them critically argumentatively;
- to classify and apply different models of responsibility ethics taught in the seminar with regard to divers applications (case studies);
- to present an analysis and application of different models of responsibility ethics taught in the course by means of examples from the field of activity;
- to present and discuss their results in a concise analytical-argumentative form.
The work must be accompanied by a graded presentation (15 - 20 minutes). The weighting of the marks is 70% for the essay and 30% for the presentation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
No knowledge.

Content:
The module introduces students to the following topics:
General issues of normative and applied ethics;
Responsibility in the professional field of civil and environmental engineering;
Recognising, classifying and evaluating professional, social-normative and ethical conflicts of objectives;

models and methods of responsible problem-solving competence;
Implementation of technical solutions (models): stakeholders, social acceptance, sustainability goals (in terms of normative guard rails, responsible communication and implementation).

Intended Learning Outcomes:
On successful completion of this module students will be:
- familiar with basic social normative and ethical challenges in the field of engineers' activities;
- understand the most important topics and issues in the field of ethics of responsibility;
- are able to analyse, classify and assess activity-related conflicts of objectives;
- are able to analyse und to discuss critically models of responsible problem-solving competence with regard to the implementation of technical solution strategies.

Teaching and Learning Methods:
The module introduces students to the following topics:
General issues of normative and applied ethics;
Responsibility in the professional field of civil and environmental engineering;
Recognising, classifying and evaluating professional, social-normative and ethical conflicts of objectives;
models and methods of responsible problem-solving competence;
Implementation of technical solutions (models): stakeholders, social acceptance, sustainability goals (in terms of normative guard rails, responsible communication and implementation).

Media:
Literature, reader, presentation and discussion

Reading List:
Resnik, David B.: The Ethics of Science. An Introduction, New York 2005.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Responsibility in the Engineering Profession. Applied Ethics for Engineers (Seminar, 2 SWS)
Wernecke J
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86114: Ethics for Engineers: Foundations, Theories, and Applications | Ethics for Engineers: Foundations, Theories, and Applications

Version of module description: Gültig ab summerterm 2025

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

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

Description of Examination Method:
In Progress...
The module will be graded with „pass – fail".

Repeat Examination:

(Recommended) Prerequisites:

Content:
The module opens with metaethics, introducing moral realism and anti-realism, cognitivism, relativism and related positions that clarify what moral claims mean and how they can be justified. It then surveys the three classical strands of normative ethics. First, virtue ethics is discussed from Aristotle to contemporary revisions, highlighting how character traits inform responsible engineering practice. Next, deontological theories are examined, beginning with Kant's categorical imperative and extending to plural duty frameworks such as Ross's prima-facie duties. A further block analyses consequentialist approaches, focusing on act and rule utilitarianism and on newer developments like negative or rule-consequentialism.
Additional sessions introduce alternative perspectives—contractualism, the ethics of care, pragmatist ethics and selected non-Western traditions such as Buddhist and Ubuntu ethics—broadening the conceptual toolkit and fostering cultural sensitivity. The programme concludes with targeted case studies in which students apply the full range of theories to areas such as sustainable energy, autonomous systems and biomedical technology, producing reasoned recommendations for engineering practice.

Intended Learning Outcomes:
On completing the module, students master the core concepts and questions of normative ethics. They articulate the leading traditions – virtue ethics, deontological theories and consequentialism – with accuracy and can contrast their respective strengths and limits. When analysing technical cases, they locate moral conflicts, choose appropriate lines of argument and draft action-oriented recommendations. Throughout, they display awareness of intercultural viewpoints and of the professional responsibility that accompanies engineering practice.

Teaching and Learning Methods:
The module consists of a lecture with integrated exercises.
The module blends asynchronous self-study with interactive learning. Concise video lectures provide the theoretical groundwork. Online reflection tasks and asynchronous, moderated discussions consolidate comprehension. Formative peer feedback sharpens the argumentative quality of the short written pieces, whereas summative quiz questions test analytical rigour.

Media:
Videobasierte Plattform

Reading List:

Responsible for Module:
Pfeffer, Jürgen; Prof. Dr. rer. soc. oec.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86114) Ethics for Engineers: Foundations, Theories, and Applications (Vorlesung mit integrierten Übungen, 2 SWS)
Matter D, Pfeffer J
For further information in this module, please click campus.tum.de or here.

Module Description

MHP00004: Football Analytics Hackathon | Football Analytics Hackathon

Version of module description: Gültig ab summerterm 2025

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:
Project work (pass/fail): including presentation (30 min) and written report: students will have to solve one of the presented challenges as a part of an interdisciplinary workgroup. This includes a running software-prototype, and a 30 min group presentation on the results. Software prototype has to proof that the develop concepts (e.g. machine learning pipelines) work and solve the problem.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Technical Analysis, Sports Informatics, Performance Analysis

Content:
The technological innovations of recent years - in particular, advances in the field of position tracking – lead to enormous amounts of data in soccer. In this module students will have to solve challenges given by an expert group including sport data scientists, professional soccer clubs and sports data companies. Students will be organized interdisciplinary workgroups including students from computer science as well as from sport science.
Challenges are related to soccer performance. The refer to an technical or tactical concept in soccer such as pressing, passing quality, line break, build up play, circle play, movements to receive, tactical formation, physical effort passing lines and much more. Based on these concepts, the students will have to:
- specify the concept from the perspective of sport science (e.g., what is a line and a line break?)
- specify the concept from the perspective of computer science (e.g., how can we model line breaks in a mathematical way?)

- develop a technical solution for detecting this concept in raw data (e.g., identifying the moment when a line break occurs)
- validate the detection quality based on video analysis (e.g., were the right moments founds?)
- calculate performance indicators based on these concept (e.g., number of line breaks, broken units, unsuccessful attempts)
- use appropriate methods from visual analytics to make the results be interpretable in an easy and intuitive way (e.g., by visualizing indicators in relation to context variables)
- interpret the results from the perspective of performance analysis (e.g., how can the results be used by a coach?)

Intended Learning Outcomes:
The general aim of the module is to introduce students to the research field of soccer analytics. After successfully completing the project, students will be able:
- to understand typical professional sport competition data (spatiotemporal tracking data, event data) and their characteristic.
- to apply methods and paradigms of computer science such as network analysis, machine learning and visual analytics for modelling phenomena in soccer.
- to develop sports data products for mass media, competition information provider and top level sports.

Teaching and Learning Methods:
In the module, students will have to solve challenges of match analysis in professional soccer. Students will work on spatiotemporal data of players and the ball provided by German professional soccer league (DFL). They will learn how to implement intelligent algorithms for deriving complex performance indicators from raw data, develop meaningful visualizations and and create added value for performance analysis. Challenges include various topics such as rating individual player actions, detection of match phases and playing styles or estimating physical workload of players. Students will be organized interdisciplinary workgroups, working independently on the challenges. The module will be realized as a block from 12.01.2026 to 17.01.2026. There will be preparation sessions in the first 4 week of the term, in which the students have to solve exercises related to the data used during the hackathon.

Media:
Slides, Videos

Reading List:
Alamar, B. C. (2013). Sports Analytics. A guide for coaches, managers, and other decision makers. NewYork:Columbia UniversityPress.
Lames, M. (2023). Performance analysis in game sports: Concepts and methods. Berlin/ Heidelberg, Germany: Springer. https://doi.org/10.1007/978-3-031-07250-5
Link, D. (2018). Sports Analytics - wie aus (kommerziellen) Sportdaten neue Möglichkeiten für die Sportwissenschaft entstehen. German Journal of Exercise and Sport Research, 48(1), 13-26. doi: 10.1007/s12662-017-0487-7

Responsible for Module:
Link, Daniel; Prof. Dr. phil. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Football Analytics Hackathon (Übung, 4 SWS)
Link D
For further information in this module, please click campus.tum.de or here.

Module Description

MHP00006: Project Week: Sleep and Circadian Health | Project Week: Sleep and Circadian Health

Project Week

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
Scientific Work:
- Final synthesis (research paper) of the research topics presented in the seminars (85%) in a 6,000-word essay
- Literature search and 20-minute presentation (15%)

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge health sciences, in particular in psychology and biomedical science

Content:
Sleep and our biological clock have a fundamental influence on our health and well-being. This seminar will be focused on concepts and research results in the area of “sleep and circadian health”. A specific focus will be on fundamental concepts and methods in chronobiology and sleep research, as well as current research methods. The seminar will take an integrative approach, incorporating also nutrition, exercise and metabolism into the understanding of the circadian clock. The seminar will be held as a hybrid seminar.

Intended Learning Outcomes:
At the end of the module students are able to:
- understand basic concepts in chronobiology and sleep research
- understand diverse state-of-the-art methods in the area of sleep and circadian health
- apply diverse state-of-the-art knowledge in the area of sleep and circadian health
- evaluate scientific presentations and presentation styles

- create syntheses of research areas

Teaching and Learning Methods:
Lectures, student-led presentations

Media:
Zoom (if hybrid participation)
Webcam and microphone (if hybrid participation)
PowerPoint presentation via Zoom (if hybrid participation)

Reading List:
Blume, C., Garbazza, C., & Spitschan, M. (2019). Effects of light on human circadian rhythms, sleep and mood. Somnologie (Berl), 23(3), 147-156. doi:10.1007/s11818-019-00215-x

Responsible for Module:
Spitschan, Manuel; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Sleep and Circadian Health (Seminar, 2 SWS)
Spitschan M
For further information in this module, please click campus.tum.de or here.

Module Description

MHP00009: Explore the Art of Dance - perceive, explore and experience creative performance processes. | Tanzkunst entdecken – wahrnehmen, explorieren und kreative Gestaltungsprozesse erfahren.

Plug-In Module

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

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

Description of Examination Method:
Practical Demonstration 1 and 3 Minutes
Report (1400 Words), 1:1

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
none

Content:
In a world with internet, smartphones and a performance-oriented society in which cognitive work is the focus, our body and the conscious use of it have taken a back seat.
This module is about exploring the possibilities of encounters between the body, posture, creativity, joy, expression, presence and connection. On the other hand, it is about experiencing the diversity in dance (in the forms it manifests itself in dance).

Students learn to get in touch with themselves and their inner and outer world through somatic mindfulness. Observing inner and outer processes is a powerful strategy for strengthening mental health.

Our movements have an impact on our nervous system, our brain function and our physical and mental health. The course links theory and practice (body and movement education). New opportunities arise to perceive, discover and feel yourself and your body, to perceive yourself in relation to yourself and others, to try things out and to bring body and mind into harmony through movement and dance. The process of developing creativity and personal design processes take priority over standardized, technology-oriented movement learning and product-oriented work.

Practical focus:
• Body and movement education
• Somatic mindfulness, embodiment, body perception, posture and presence
• Exploring space (inner, outer, imaginary)
• Exploration, expression and presence
• Creativity, improvisation, design
• Diversity of manifestations in dance
• Dance and cultural education
• Dance and cross-topic work
• Feedback culture
• Process and product-oriented design of movements (individually, in a partner, in a group)
• Experimenting with objects and materials
• Acceptance Dance (dance and inclusion/neurodiversity), posture training
Theoretical focus
• Connections between neuroscience, neurobiology, brain research, dance science, somatic mindfulness and body and movement education (embodiment)
• Mental health
• Theoretical foundations of the gymnastics & dance department

Intended Learning Outcomes:
After completing the module, students will be able to remember and understand the basic concepts of somatic mindfulness, creativity, improvisation, process- and product-oriented work, as well as terms from the field of dance. They will be able to implement a variety of dance-practical and theoretical principles regarding dance-specific forms of movement (also regarding different manifestations of dance: hip hop, contemporary dance, creative dance, folk dance/cultural education). They will also have experienced techniques and methods of artistic, creative processes and reflection processes.

Specifically, students will be able to...

- Perceive their body more consciously (self-perception) and direct their attention in a targeted manner with the help of somatic mindfulness.
- Look at space in all its diversity, personal space (inside), external space and imaginary space.
- Consciously come into contact with themselves and others.
- Classify dance with its diverse manifestations.
- Experience the special nature of individual creative learning processes and sensual-aesthetic processes and use them consciously
- Differentiate between skills that can be trained through dance and movement: social, emotional, cognitive, sensorimotor, creative and artistic.
- Recognize and differentiate between dance methods such as structured improvisation, compositional processes, deductive and inductive.

- Name and apply choreographic principles. They are able to look at music in terms of tempo, beat, formal structure and musical peculiarities and can apply the music theory knowledge they have gained in dance designs. The Students are able to create movement designs themselves and to differentiate and reflect on the compositional principles of time, space and dynamics.
- Express themselves through movement, music and dance and understand the phases of creative processes.
- Present themselves.
- Observe and reflect on their own attitudes and actions, also based on their own and others' perceptions.
- Transfer, transfer personal knowledge to other areas (study, work, private life) and develop it further independently.

Teaching and Learning Methods:
Individual, partner and group work, cooperative learning methods, practical exercises, exploratory learning, improvisation

Media:
Presentation, Moodle, TUMonline,
-use of music, video examples, video analysis, Power Point, script, flip chart

Reading List:
KALTWASSER, V. (2016). Mindfulness in school. Self-regulation and relationship skills as the basis of education. Weinheim: Beltz.

KINGE, A. (2019/2017). On the knowledge of the body and its educational potential in sport and dance. Kubi-Online. https://www.kubi-online.de/artikel/wissen-des-koerpers-seinen-bildungspotenzialen-sport-tanz (13.9.2024)

PIETSCH, S. (2020). Kompetenzentwicklung durch und über den Körper am Beispiel Tanz im Kontext pädagogischer Studiengänge. Dissertation.

RYAN R. M., Deci E.L. (2000). Self- determination theory and the facilitation of intrinsic motivation, social development and well-being. Am Psychol. 55, 68-78. 10.1037/0003-066X.55.1.68

SCHWENDER, T. Spengler S, Oedl C and Mess F (2018). Effects of Dance Interventions on Aspects of the Participants' Self: A Systematic Review. Front. Psychol. 9:1130. doi: 10.3389/fpsyg.2018.01130.

STOLZ, S. A. (2015). Embodied Learning. Educational Philosophy and Theory 47, 474–487. doi: 10.1080/00131857.2013.879694.

STORCH, M., CANTIENI, B., HÜTHER G., TSCHACHER W., (2022): Embodiment. Understanding and using the interaction between body and mind. Göttingen: hogrefe

Responsible for Module:
Lisa Lugo

Courses (Type of course, Weekly hours per semester), Instructor:
Tanzkunst entdecken – wahrnehmen, explorieren und kreative Gestaltungsprozesse erfahren (Übung, 2 SWS)
Lugo L
For further information in this module, please click campus.tum.de or here.

Module Description

MHP00010: Computational Modeling of Motivation, Emotion & Coping | Computational Modeling of Motivation, Emotion & Coping

Integrating Control Systems, Artificial Intelligence, and Neuroscience

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
Pass/fail: Project Work (Report and Presentation)
The aim of the project work is to solve a theoretical or implementation-related problem, which is developed over several phases (initiation, problem definition, role distribution, idea generation, criteria development, decision-making, execution, documentation, presentation). The corresponding project task should be completed within 3 months using appropriate resources (literature research, programming environments, PowerPoint, Word). The project work concludes with a comprehensive documentation (between 2000 and 5000 words) and presentation (20 min + 25 min discussion) of the task. The project work can also be done in a group. The project will be evaluated on a pass/fail basis ("successful" vs. "unsuccessful"; no grades).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
- An introductory course in psychology/motivation/emotion, cognitive science, neuroscience, or computational methods is recommended.
- Basic knowledge of programming and statistical analysis will be beneficial.

Content:
- Foundations of Motivation, Emotion and Coping: Key concepts in motivation; Zurich Model of Social Motivation; Neuroscientific underpinnings of motivation and coping
- Computational Modeling: Basics of computational thinking and programming
- Modeling techniques: agent-based models, machine learning, simulations
- Modeling Motivation and Coping: Techniques for representing motivational, stress, and coping processes in computational models; case studies and practical examples

- Integrated Modeling Approaches: Combining the modeling of motivation and coping; applications in predicting behavioral responses to situational changes and challenges
- Project Development and Presentation: Guidance on developing individual research projects; presentation of projects and peer feedback sessions

Intended Learning Outcomes:
Students are able to:
- understand theories of motivation, emotion and coping, and understand their application in psychological research.
- apply computational tools and techniques, including agent-based modeling, machine learning, and simulation, to model psychological phenomena.
- create and apply computational models to investigate questions related to motivation, emotion and coping.
- conduct a computer simulation or a part of an empirical research project or program a code that integrates theoretical and computational approaches, culminating in a comprehensive report and presentation.

Teaching and Learning Methods:
Presentations, Discussions, Group/Project Work, Inquiry-Based Teaching, Case Studies, Computer Simulations, Blended Learning, Flipped Classroom,
Self-Study, Study Groups, Peer Learning, Feedback, Problem-Based Learning (PBL), Brainstorming

Media:
Academic articles (PDF), PowerPoint presentations,Educational videos, Recorded lectures, Hybrid events via Zoom, Computer simulations (MATLAB/Simulink), WhatsApp groups

Reading List:
Basic Literature:
Bischof, N. (2016). Struktur und Bedeutung. Eine Einführung in die Systemtheorie für Psychologen, Biologen und Sozialwissenschaftler zum Selbststudium und für den Gruppenunterricht [Structure and Meaning: An Introduction to Systems Theory for Psychologists, Biologists, and Social Scientists for Self-Study and Group Instruction]. 3., überarbeitete und neu illustrierte Auflage. Bern: Hans Huber.
Kuhl, J., Quirin, M. (2024). Persönlichkeitspsychologie: Motivation, Kognition und Selbststeuerung [Personality Psychology: Motivation, Cognition, and Self-Regulation]. Göttingen: Hogrefe.

Additional Literature:
Research articles and book chapters to be announced.

Responsible for Module:
Quirin, Markus; Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Computational Modeling of Motivation, Emotion & Coping (Seminar, 2 SWS)
Quirin M
For further information in this module, please click campus.tum.de or here.

Module Description

MH110036: Scientific Methods in Workplace Health Promotion | Wissenschaftliche Methoden in der Betrieblichen Gesundheitsförderung

Version of module description: Gültig ab summerterm 2025

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 67.5	**Contact Hours:** 22.5

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

Description of Examination Method:
Scientific Work:
The examination takes the form of a scientific paper with a presentation in the seminar (50 % written research paper, 50 % presentation in small group: 15 minutes in total). The students prepare a short scientific presentation on selected topics, prepare the corresponding empirical data for the seminar, present these in plenary, and discuss them with all course participants. The students work on a joint presentation in small groups. Each person presents for 5-10 minutes (including discussion). In addition, each person prepares a mini scoping review on a selected topic with research and preparation of the literature in the form of a seminar paper.

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge of health promotion and prevention with reference to different environments and target groups – ideally with a focus on employees in the workplace setting – is a prerequisite. It is recommended that the students have their own laptops to work on the content in RStudio

Content:
As part of the seminar, students learn how to process empirical data from scientific surveys in the occupational setting using the RStudio software. This data will be analyzed in small groups and interpreted, discussed, and presented in the context of specific topics (e.g., mental health, health-relevant behaviors such as exercise, nutrition, and sleep, mobile employees, presenteeism, shift workers, etc.) against the background of the current state of research. Furthermore, students will systematically develop the current state of research on one of these topics in the occupational setting by preparing a scoping review. In addition, interactive focal points for health promotion in

the workplace are developed in the seminar together with the lecturers in order to identify possible transfers for workplace health promotion programs.

Intended Learning Outcomes:
After successfully completing the module, students will be able to
- Understand in-depth studies and applications of topics (models, strategies, and implementation) of health promotion and prevention in the workplace
- Process, evaluate, and visualize scientific data on health promotion and prevention in the workplace using common statistical methods in RStudio
- Develop selected health topics in the workplace setting and present them in conjunction with selected data
- Apply scientific methods when researching and preparing literature (formulating questions, creating a search strategy, screening, extraction, and presentation)

Teaching and Learning Methods:
The seminar combines theoretical and methodological impulses from the lecturers with application-oriented group and individual work phases to achieve the learning objectives. Various thematic focuses and associated empirical data sets and research strategies are discussed together and then worked on in depth in small groups as a transfer to the students' own focus topics. The students analyze the data, link it to the current state of research, and present or discuss their results in the seminar. The independent preparation of a scoping review promotes systematic examination of the current state of research and, among other things, the methodological skills of the students on the respective focus topics. Interactive methods, self-directed learning, presentations, and written submissions strengthen both subject-specific and methodological skills as well as self-awareness and personal responsibility in the learning process.

Media:
- Literature (scientific articles and textbooks)
- RStudio statistical software
- Tools for the preparation of reviews
- presentations

Reading List:
Bamberg, E., Ducki, A. & Metz, A.-M. (2011). Gesundheitsförderung und Gesundheitsmanagement in der Arbeitswelt: Ein Handbuch (Innovatives Management). Göttingen: Hogrefe.
Uhle, T. & Treier, M. (2019). Betriebliches Gesundheitsmanagement: Gesundheitsförderung in der Arbeitswelt - Mitarbeiter einbinden, Prozesse gestalten, Erfolge messen (4., vollst. aktual. u. erw. Aufl.). Berlin: Springer.

Responsible for Module:
Friedrich, Julian; Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Wissenschaftliche Methoden in der betrieblichen Gesundheitsförderung (Seminar, 2 SWS)

Blaschke S, Friedrich J, Herz M
For further information in this module, please click campus.tum.de or here.

Module Description

MH111022: Workplace Health Promotion | Grundlagen und Anwendungen der Betrieblichen Gesundheitsförderung

Version of module description: Gültig ab summerterm 2025

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

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

Description of Examination Method:
The examination takes the form of a written examination (60 min). In this exam, students must demonstrate that they are able to theoretically justify, apply and critically reflect on the fundamentals and practical applications (target groups, topics, etc.) of workplace health promotion and workplace health management in a limited amount of time and without any aids. The answers require both independent formulations and the marking of given multiple answers.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module “Healthcare systems”

Content:
As part of the lecture, students will learn the fundamental concepts, models, legal aspects, processes, and analytical methods in Workplace Health Promotion (WHP) and Workplace Health Management (WHM). In addition, key topics and target group-specific characteristics in WHP/WHM will be explored in greater depth, always in the context of current societal and health-related developments relevant to the workplace environment.

To introduce, implement, and evaluate a systematic and sustainable WHP/WHM, the necessary procedures will be simulated with students using the PDCA cycle. Best-practice examples from various companies will be used throughout to illustrate the concepts.

Typical analysis methods introduced to students include employee surveys, workplace inspections, interviews, and health circles. Classical behavioral prevention measures (nutrition, physical activity, addiction, etc.), leadership training, health circles, and workplace programs will be discussed in terms of their theoretical design and applied through practical examples.

Common evaluation criteria and potential indicators such as participation rates, satisfaction, surveys, and sickness absence measurements will be critically examined. In addition to the theoretical content, WHM experts from companies and public institutions will occasionally be invited ("meet the expert") to provide insights into the challenges of WHM from the perspective of those responsible, allowing for analysis and joint discussion.

Intended Learning Outcomes:
After successfully completing the module, students will be able to:

- Understand the fundamentals of health promotion, prevention (including analytical methods, topics, target groups, etc.), and workplace health promotion programs.
- Analyze and further develop existing workplace health promotion programs.
- Design exemplary workplace health promotion programs tailored to specific topics and target groups.
- Plan topic- and/or target group-specific studies in the context of workplace health promotion.

Teaching and Learning Methods:
In the lecture, key elements and subfields as well as fundamental theories and areas of application of Workplace Health Promotion (WHP) and Workplace Health Management (WHM) are conveyed through an interactive lecture format. Guest contributions may occasionally complement the lecturer’s presentation. Presentations are used to support the delivery of knowledge. Students are expected to supplement the presented content through self-study using the literature specified in advance.

Media:
Presentations

Reading List:
Bamberg, E., Ducki, A. & Metz, A.-M. (2011). Gesundheitsförderung und Gesundheitsmanagement in der Arbeitswelt: Ein Handbuch (Innovatives Management). Göttingen: Hogrefe.
Hurrelmann, K. & Klotz, T. (2014). Lehrbuch Prävention und Gesundheitsförderung (4., sollst. überrag. Aufl.). Göttingen: Hogrefe.
Uhle, T. & Treier, M. (2019). Betriebliches Gesundheitsmanagement: Gesundheitsförderung in der Arbeitswelt - Mitarbeiter einbinden, Prozesse gestalten, Erfolge messen (4., vollst. aktual. u. erw. Aufl.). Berlin: Springer.

Responsible for Module:
Mess, Filip; Prof. Dr. rer. soc.

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen des Betrieblichen Gesundheitsmanagements (Seminar, 2 SWS)

Blaschke S, Friedrich J, Herz M, Mess F, Schmickler J
For further information in this module, please click campus.tum.de or here.

Module Description

MH160035: Medicine in the Tropics and Global Health | Medicine in the Tropics and Global Health

Medicine in the Tropics and Global Health

Version of module description: Gültig ab winterterm 2024/25

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 26	**Self-study Hours:** 90	**Contact Hours:** 64

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

Description of Examination Method:
20 min presentation of a module topic-related paper

The grading is based on a 20 min paper presentation followed by questions (total 30 min). This occurs at the end of the semester and the students present a paper of their choice related to one of the module topics. With the presentation, students have to show that they have understood the relevance of the topic and the translational aspects into global health perspectives and the Sustainable Developmental Goals (SDG). How the student introduces the topic in the paper, concisely presents the data/information, and accurately discusses the findings are evaluated.

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
- Introduction: Medicine in the tropics and Global Health
- Women's Health in LMIC: what are the challenges?
- Malaria: from physiology to novel vaccines
- Hepatic diseases in the tropics and how Egypt combats it's Hepatitis C epidemic
- Surgery in the tropics
- Introduction into NTDs and leishmaniases
- A look into helminthic NTDs: Filarial diseases and schistosomiasis
- Special bacterial diseases in the tropics: from anthrax to leprosy and Buruli ulcer
- Microbiota and its Manipulation for Health

- Two sides of the same “Trypanosome” coin? Sleeping sickness and Chagas disease
- HIV/AIDS in Africa: clinical perspectives and experiences
- Practical laboratory short course

Intended Learning Outcomes:
At the end of the module, students will be able to (1) understand the evolution of global health and how it can be achieved through the integration of interdisciplinary approaches in LMIC context, (2) recognize the particularities of relevant and neglected diseases in the tropics, and the socioeconomic impacts as well as the challenges posed by climate-sensitive diseases (e.g. dengue), (3) understand the role of cultural, geographical, and environmental factors in healthcare delivery for contextual health interventions, (4) examine the interplay between nutrition, infections, environmental factors, and global health outcomes, with a focus on malnutrition, and the role of microbiota in health, (5) develop practical skills to recognize disease transmitting vectors and diagnostic tools for resource-limited tropical settings.

Teaching and Learning Methods:
The module consists of eleven lecture series, each of which includes one session of two hours held by guest speakers to reflect on how classical "tropical medicine" or "medicine in the tropics" which originated in colonial times and was largely focused on diseases primarily endemic in these regions, is now embedded in the concept of "Global Health”. Students will be provided with the lecture slides a week before to prepare for each lecture, in addition to referenced literature they will be asked to read. The sessions are interactive and students will be encouraged to prepare topic-related questions to be discussed. The course will conclude with a practical teaching unit in which students will be instructed to carry out independent blood and stool diagnostics in a "mini-laboratory" customary in the tropics. Further, live disease-transmitting vectors such as Anopheles, freshwater snails and Tsetse flies will also be demonstrated.

Media:
Lecture slides will be available via Moodle

Reading List:
- Beeching N, Gill G: Tropical Medicine, 7th Edition
- Manson's Tropical Infectious Diseases, 23rd Edition
- Gyapong J, Boatin B: Neglected Tropical Diseases, Sub-Saharan Africa, 2024
- Barrie J 2016: Schistosoma - Biology, Pathology and Control
- Takken W, Knols B: Emerging pests and vector-borne diseases in Europe
- Lancet Perspectives: Volume 377, Issue 9773, p1230, April 09, 2011

Responsible for Module:
Dr. Fabien Ulrich Prodjinotho / Prof. Dr. med. Clarissa Prazeres da Costa

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

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

Module Description

POL65101: Global Health (MSc.) | Global Health (MSc.)

Part 1: Introduction to Global Health, Part 2: Gender Disparities in Health and Development

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
The examination consists of a research paper ("Policy Brief", approx. 6-7 pages), which tests students' ability to identify key challenges of global health in a selected country and develop evidence-based policy recommendations to promote population health in the given context. A
As part of a mid-term examination, students may voluntarily hold a 15-20 minute presentation discussing and critically evaluating a selected empirical paper. In this presentation, students demonstrate their competence in applying basic concepts of the Global Health discipline and interpreting and critically appraising relevant empirical studies. Successful completion of the mid-term will lead to a +0.3 bonus on the final grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Quantitative methods

Content:
The module provides a general introduction to the global health discipline, whereby specific focus is placed on developments and processes in countries of the Global South. The first part (seminar 1) defines the global health discipline in relation to other disciplines such as public health and epidemiology, introduces basic concepts and terms, and sheds light on associations between health and development. Further, it discusses trends in the global burden of disease and critically appraises different approaches to the measurement of disease. Lastly, the seminar discusses various intervention strategies on a policy- and individual level and evaluates their theoretical

foundations and empirical evidence. The second part (seminar 2) looks at health and development through a gender lense. It first discusses different approaches to the measurement of (gender) inequality and covers various additional topics, including Amartya Sen's theory on "Missing Women" as welll as related empirical studies, differences between matrilineal and patrilineal societies, fertility and reporoductive health, and gender-based violence.

Intended Learning Outcomes:
Upon successful completion of the module, students are able to define basic concepts and terms of the global health discipline. Moreover, students are able to reflect on trends in the spread and global prevalence of important communicable and non-communicable diseases as well as comment and criticise strategies for their prevention or treatment. In addition, students are able to explain macro-relationships between poverty and health, and to assess the impact of various health interventions and health promotion policies. Lastly, students can summarise, interpret, and assess the findings of influential empirical studies.

Teaching and Learning Methods:
The module consists of two seminars. The first seminar ("Introduction to Global Health", 2 SWS) is focused on the theoretical and conceptual foundations of the discipline and introduces key topics and empirical papers on global health. The second seminar ("Gender Disparities in Health and Development", 2 SWS) provides a more in-depth discussion of global health and development topics with a focus on gender. The module is taught in a combination of teacher-centered lectures, interactive discussions, student presentations, and occasional group work.

Media:
multimedia-supported

Reading List:
Skolnik, R. (2019). Global health 101 (3rd or 4th Edition). Jones & Bartlett Publishers.

Responsible for Module:
Steinert, Janina; Prof. Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
(POL65101) Global Health (MSc) (Introduction to Global Health and Gender Disparities) (Seminar, 4 SWS)
Steinert J (Gruschwitz B)
For further information in this module, please click campus.tum.de or here.

Module Description

LS40026: Digest - A Student Social Media Project | Der Verdauungskanal – Ein Studentisches Social Media Projekt

Version of module description: Gültig ab summerterm 2025

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 90	**Self-study Hours:** 75	**Contact Hours:** 15

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

Description of Examination Method:
Die Prüfungsleistung wird im Rahmen eines Lernportfolios erbracht.
Die Studierenden sammeln dafür Ideen, Textfragmente und Entwürfe zu den zwei von Ihnen federführend geplanten Beiträgen. Das einzureichende Portfolio zielt darauf ab, die eigenen Überlegungen, Kompetenzen und den Fortschritt ihrer Leistungen anhand ihrer themenbezogenen Arbeiten in einer Mappe zu dokumentieren. Im Lernportfolio soll nachgewiesen werden, dass Sie im Projekt eigene Verantwortung für inhaltliche und gestalterische Themen übernommen haben und Beiträge fristgerecht erstellt haben. Das Portfolio dokumentiert zum Ende der Projektphase den Lernfortschritt und Leistungsstand anhand Ihrer Beiträge für den Social-Media-Kanal. Erklären Sie hier zum Beispiel, warum Sie diese Überschrift gewählt haben und welcher Alternativtext verworfen wurde.
Bei der Bewertung des Lernportfolios spielt die Fähigkeit zur sachbezogenen Selbstreflexion bei der Kommunikation von wissenschaftlichen Inhalten an ein Laienpublikum eine große Rolle. Im Mittelpunkt steht dabei eine Überarbeitung der ersten Auswahl, ein Verwerfen einer Konzeption, ein Umsteuern bei der Gliederung oder das Reformulieren der ursprünglichen Idee. Anstoß für die Überarbeitung kann dabei die Diskussion der Entwürfe im Team oder mit dem betreuenden Dozierenden sein. Auch ein technisches Scheitern der geplanten Umsetzung kann Anlass für eine veränderte Konzeption sein.
Ziel des Portfolios ist es, nicht nur das finale Resultat darzustellen, sondern den Reifeprozess, den die Grundidee bis zum Endprodukt zurückgelegt hat.
Dabei ist auch die Gruppendynamik von Bedeutung: Wie gut hat die Gruppe zusammengearbeitet? Wie haben gut haben sich die Mitglieder gegenseitig geholfen und Schwierigkeiten gemeinsam überwunden. Wer hat welche Kompetenzen zur Verfügung gestellt? Wie gut wurden Kompetenzen aus anderen Gruppen einbezogen?
Das Portfolio wird zwei Wochen vor Ende der Vorlesungszeit eingereicht und soll maximal 6 Seiten im Format DINA4 umfassen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Interesse an der Kommunikation wissenschaftlicher Inhalte an ein Laienpublikum
Freude am Gestalten in verschiedenen Medien (Foto, Video, Grafik, Text)
Begeisterung für und erste Erfahrungen in Social Media
Hohe Eigenmotivation und fristgerechte Erstellung von Posts
Zuverlässigkeit und konstante Betreuung des aufgebauten Social Media-Kanals im Team
Lust zum Einbringen persönlicher Ideen und Fähigkeiten
Interesse Ziele und Ausrichtung des Kanals mitzugestalten

Dabei wird angestrebt, alle Projektteams gemischt zu besetzen. Dies bedeutet, dass kein Studierender alle Voraussetzungen mitbringen muss und sich vielfältige Möglichkeiten ergeben, von den Kompetenzen der anderen Teammitglieder zu lernen.

Content:
Planung einer Social Media Initiative: Welche Zielgruppe soll angesprochen werden, was wollen wir erreichen, wir soll das erreicht werden? Dies beinhaltet die Beurteilung bestehender ähnlicher Angebote, Definition von best und worst practices.
Erstellung von Beiträgen für die Social Media Initiative: Planung von Beiträgen in verschiedenen auch gemischten Formaten (Bild, Text, Video), Erlernen und Umgang mit den jeweils notwendigen kreativen Werkzeugen, Visualisierung komplexer Sachverhalte, Erarbeitung einer gemeinsamen Text- und Bildsprache.
Laufender Betrieb: Management von Reaktionen, teilen anderer Inhalte, folgen anderer Kanäle
Evaluationsphase: Welche Posts haben die meisten Reaktionen erzeugt, wer hat Inhalte geteilt, wer hat Kommentare abgegeben.

Die im Social-Media-Kanal aufbereiteten Inhalte richten sich nach den Interessen der beim Projekt mitarbeitenden Studierenden und werden in der Initiationsphase festgelegt. Die einzelnen Beiträge werden dann in kleineren Teams in enger Abstimmung mit dem jeweils betreuenden Dozierenden erstellt. Dabei übernimmt jede Teilnehmerin/jeder Teilnehmer federführend die Gestaltung von mindestens zwei Beiträgen in unterschiedlichen Beitragsarten (Post, Reel, Video), Die wesentlichen Impulse zu Inhalt und Gestaltung stammen dabei vom jeweiligen Studierenden. Die Schritte bis zum finalen Beitrag beziehen Diskussionen im Team und Anstöße vom betreuenden Dozierenden ein. Insbesondere soll jede Teilnehmerin / jeder Teilnehmer von den bei anderen Teammitgliedern oder in anderen Projektgruppen vorhandenen Kompetenzen Gebrauch machen, um den eigenen Beitrag zu verbessern und fehlende Kompetenzen zu erwerben. Zur Sicherung einer hohen wissenschaftlichen Qualität müssen die Beiträge vor der Veröffentlichung vom jeweiligen Dozierenden freigegeben werden.

Mögliche Themenfelder sind:
• Supplemente – brauchen wir welche?
• Ballaststoffe – Hype oder Hoffnung

• Kurze Berichte zur aktuellen Forschung am Campus
• Kurze Spotlights aus (Praxis)-Lehrveranstaltungen
• Ernährung in kritischen Lebensphasen
• Kritische Auseinandersetzung mit Werbeaussagen und Inhaltsstoffen
• Ernährungsmythen im Sport

Intended Learning Outcomes:
Im Projekt wird durch die Studierenden ein Social-Media Kanal aufgebaut, der zum Ziel hat, verlässliche ernährungsbezogene Informationen für eine breitere Öffentlichkeit aufzubereiten.

Nach der Teilnahme an dem interdisziplinären Projekt sind die Studierenden in der Lage, eine Social Media Initiative zu planen. Sie können Ziele entwickeln, Zielgruppen identifizieren und bereits bestehende ähnliche Angebote analysieren und bewerten. Sie definieren eine gemeinsame Text- und Bildsprache, kreieren Beiträge in verschiedenen Formaten (Bild, Text, Video) mit dafür geeigneten Anwendungen und visualisieren damit komplexe Sachverhalte. Sie stimmen sich hinsichtlich des Managements auf Reaktionen ab und evaluieren den Erfolg des Social-Media-Kanals.

In der Summe reflektieren die Teilnehmenden den Bedarf für eigenes Fachwissen um wissenschaftlich sprechfähig zu werden und Inhalte einfach aber strukturiert aufzubereiten. Sie erhalten Einblick in andere Tätigkeitsfelder (visuelles Gestalten und kreatives Schreiben), die für die Vermittlung der Inhalte erforderlich sind. Sie lernen, in heterogenen Teams produktiv zu arbeiten, erleben die Verschränkung der eigenen Disziplin mit anderen Disziplinen (z. B. wissenschaftliche Fragen mit gestalterischen Aspekten), und gewinnen dabei Wertschätzung für andere Disziplinen.

Teaching and Learning Methods:
In einer Initialphase werden in Plenarveranstaltungen und Gruppendiskussionen die Zielgruppen, Ziele und die zur Kommunikation an diese Zielgruppen geeignete Methoden festgelegt.
Nach dieser Plenar-Phase formieren sich Projektteams aus 5-7 Studierenden. Die Teams werden gemischt besetzt, so dass sich in jedem Team sowohl fachlich Interessierte als auch in gestalterischen Aufgaben versierte Studierende befinden. In dieser Mischung profitieren die fachkundigen Studierenden von den Gestaltungsvorschlägen und kreativen Ideen. Die künstlerisch versierten Studierenden sind dabei gleichzeitig ein Testpublikum, bei dem die Kommunikation von Wissenschaft an Laien ausprobiert werden kann.
Jedes Projektteam ist einem Dozierenden zugeordnet, der steuernd und beratend mitwirkt und die erstellten Beiträge vor deren Veröffentlichung begutachtet und freigibt.

Media:

Reading List:
Godemann J, Bartelmeß T (Hrsg.): Ernährungskommunikation: Interdisziplinäre Perspektiven – Theorien – Methoden. Springer, 2021

Endres, E.: Ernährungsbildung durch Social Media. In: Nachhaltigkeit und Social Media. Springer, 2022, pp 223-239.

Responsible for Module:
Stolz, Jürgen, PD Dr. rer. nat. habil. stolz@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Der Verdauungskanal – eine studentische Social Media Initiative (Projekt, 1 SWS)
Stolz J [L], Stolz J, Brandl B, Geyer K, Raab R, Rath E, Bartelt A, Klingenspor M, Köhler K, Ocvirk S, Miesera S, Skurk T
For further information in this module, please click campus.tum.de or here.

Module Description

ED0341: STS 2: Philosophy of Science and Technology | STS 2: Philosophy of Science and Technology [STS 2]

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
The examination consists of a research paper (1500 to 2000 words) and an in-class presentation (15 to 20 minutes). In the research paper, students demonstrate their ability to portray and discuss contemporary philosophical debates on key ideas in the philosophy of science and technology, and to identify, defend and criticize philosophical points of view. In the presentation, students demonstrate that they are able to communicate their analysis of the chosen topic clearly and concisely.
Grading: the research paper counts for 70%, the presentation for 30% of the final grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
The module provides an introduction to central topics in the philosophy of science and technology. With a focus on the 20th century and contemporary approaches, it identifies major philosophical strands and schools, such as logical positivism, hypothetico-deductivism, social constructivism, the practice turn, and technoscience. Each session is dedicated to one of these specific topics. For each topic, the major positions are outlined, and the respective pros and cons are discussed. By the same token, some of the most influential authors in the field are introduced. Issues addressed are:
- paradigms of scientific method - induction versus deduction
- structure of scientific theories - semantic versus syntactic views
- the relevance of scientific practice - the role of models and experiments
- theory change and scientific revolutions - rationalism versus relativism

- the science-technology relationship - autonomy of technology versus applied science
- the nature of technical artefacts
- critical theories of technology

Intended Learning Outcomes:
Upon completion of this module the students
- understand a wide range of philosophical issues concerning science and technology
- are able to portray contemporary philosophical debates, for example on the nature of science and technology, on the relationship between science and technology, or on scientific methods and rationality
- have conceptual and analytical skills to identify, defend and criticize philosophical points of view
- are able to engage in philosophical argumentation on science and technology in a clear and structured manner

Teaching and Learning Methods:
A variety of methods are used to convey different perspectives on the content of the module. Lecture elements provide essential background information that enables the students to understand the relevant literature and engage in discussions. In preparation for each session, the students are given a reading assignment with questions they need to work on. The reading assignments comprise classical texts from the philosophy of science and technology, selected with the aim of familiarising students with influential authors and their styles of philosophical argumentation and writing. In-class presentations ensure that the students are able to summarize and adequately structure the contents of these readings. Of particular importance are in-class discussions that allow students to propose hypotheses, exchange arguments, and develop well-founded positions on exemplary questions from the philosophy of science and technology.

Media:
Texts, slide presentations, flipchart/whiteboard, worksheets, Moodle

Reading List:
Carnap, R. An Introduction to the Philosophy of Science. Dover, New York, 1995
Chalmers, A. F. What's this thing called science?, 3rd ed. Hackett, Indianapolis/Cambridge, 1999.
Dusek, V. Philosophy of Technology: An Introduction. Blackwell, Malden, 2006.
Ihde, D. The historical-ontological priority of technology over science. In Philosophy and Technology, P. T. Durbin and F. Rapp, Eds. Reidel, Dordrecht, 1983, pp. 235-252.
Kuhn, T. S. The Essential Tension. University of Chicago Press, Chicago, 1977, Ch. 9.

Responsible for Module:
Wernecke, Jörg-Wilhelm; PD Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
STS 2: Philosophy of Science and Technology (Seminar, 3 SWS)
Jones E, Leonelli S
For further information in this module, please click campus.tum.de or here.

Module Description

ED0384: Active Learning | Active Learning [ActiveLearning]

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:** 120	**Contact Hours:** 30

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

Description of Examination Method:
The students will have to master the theoretical background and the computational bases of information search and active learning theories and models, tackled from a developmental perspective. This seminar is an active experience, and requires students' full engagement. Participation includes active involvement in class discussions and activities: asking questions about the topics and subject matter and expressing themselves through comments and opinions. Active contributions to in-class discussions count toward your pass/fail grade. To pass the seminar and earn credits for the course, students will be additionally required to write a 3-4 pages paper about the research project they have been working on during the Active Learning workshop. In case students decide to get a number grade for their participation in the seminar, their paper will be graded. This is how the grade will be determined:
- Research article commentaries, discussion and presentation (4 * 5% per lecture day): 20%
- Active Learning workshop participation (4 * 15% per lecture day): 60%
- Research paper: 20%

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Students must have a basic understanding of introductory statistics (descriptive statistics, correlation) from their Bachelor's studies and from Module 1 "Introduction to Methods in Teaching and Learning Science"

Content:
How do young children learn so much about the world, so quickly? A rich body of research has demonstrated that that active engagement with the world is a crucial component of learning: As soon as they can sit or walk,

infants spontaneously grab and manipulate objects and approach or avoid people. As language develops, young children ask about the meaning of words, request the labels of objects, and inquire about the many new and puzzling phenomena they encounter. Active learning has been a topic of interest for philosophers, psychologists, cognitive and computer scientists.

What is active learning? Are children efficient active learners? Is there a developmental trajectory for active learning? Is active learning better than more passive forms of instruction? This seminar examines these questions across domains such as visual attention, hysical reasoning, causal learning, and problem solving; readings will also address issues in explanation, exploration, and other related topics. The seminar involves a mix of lectures, group readings and discussions, as well as an active learning workshop designed to offer students a hands-on experience on how questions related to active learning are investigated experimentally, from identifying the research questions and hypotheses to interpreting and presenting the results obtained.

Intended Learning Outcomes:
At the end of the module, students will be familiar with the theoretical background and the computational bases of information search and active learning theories and models, tackled from a develpomental perspective, and will have developed an understanding of how the results from active learning research can impact education.

Teaching and Learning Methods:
This course is an active experience, and requires students' full engagement. Participation includes active involvement in class discussions and activities: asking questions about the topics and subject matter and expressing themselves through comments and opinions.

Lectures. The seminar comprises four lectures, corresponding to the four seminar days. For all lectures we will suggest a few readings. Students are supposed to read suggested papers prior to the class for which they are listed. Lectures will not go over the specific content of the readings, but rather build upon the content of the readings. In other words, lectures will never merely repeat information in the readings. Therefore, students are responsible for understanding what they read, asking questions about what they do not understand, and being prepared to go beyond the readings in class. All suggested readings will be available on Moodle.

Research Article Commentaries, Discussions and Presentation.
Throughout the seminar, students will be asked to read eight research articles (two per day) and to prepare at least two written questions and/or critical comments per paper, demonstrating that they have horoughly read, understood, and thought about each article. Discussion will take place in class, and will be followed by a group activity, in which students will be asked to either prepare a short presentation or to write a blog post about one of the research articles discussed. All research articles will be available on Moodle.

Active Learning workshop. This group workshop is designed to offer students a hands-on experience on how questions related to active learning are investigated experimentally. It is divided

in four blocks (one per seminar day), each roughly corresponding to an experimental research phase:
1. Identify an interesting research topic; narrow it down to a research question; do some background research to get familiar with what has been done on the topic, and to make sure the question is original; evelop one or few competing hypotheses;
2. Design a simple study aimed at answer the research question and test the hypotheses; prepare the materials and the instructions;
3. Test (test modalities will depend on the design the group has developed);
4. Analyze, interpret and present the results. At the end of each seminar day, each group will present its progress to the rest of the class.

Media:
Projector, Keynote presentations; board; flipcharts.

Reading List:
Readings are defined in the course.

Responsible for Module:
Ruggeri, Azzurra; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Active Learning (Seminar, 2 SWS)
Ruggeri A, Török G
For further information in this module, please click campus.tum.de or here.

Module Description

SOT10069: Introduction to Psychology and Human Behavior | Introduction to Psychology and Human Behavior

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Die Prüfungsleistung wird als 90-minütige Klausur erbracht. Diese prüft die Reproduktion, Reorganisation und den Transfer des in der Lehrveranstaltung erlernten Wissens. Neben der Überprüfung des Kenntnisstands hinsichtlich psychologischer Grundbegriffe, Modelle und Studien zielen die Fragen auch auf die Anwendung der Inhalte im beruflichen und alltäglichen Kontext. Das Frageformat besteht aus Single-Choice-Fragen, ggf. kann auch auf eine automatisierte Auswertung offener Fragen zurückgegriffen werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Die Lehrveranstaltung ist eine Einführung in die Psychologie. Im Zentrum steht das menschliche Handeln und die Kernfragen: Warum handeln Menschen wie sie handeln? Welche Rolle spielt ihre Umgebung? Wie lässt sich das menschliche Handeln untersuchen?
Die Studierenden erhalten Einblicke in verschiedene Teilbereiche der Psychologie (z. B. Lernpsychologie, Arbeits- und Organisationspsychologie, Sozialpsychologie). Anhand aktueller Studien und Forschungsergebnisse gibt die Lehrveranstaltung einen Überblick über ausgewählte psychologische Modelle und Theorie sowie unterschiedliche Methoden der Psychologie.

Intended Learning Outcomes:
Die Studierenden können Grundbegriffe und Methoden der Psychologie sowie psychologische Modelle wiedergeben und Bezüge zu ihrem berufspraktischen Alltag ziehen.

Teaching and Learning Methods:
Die Lehrveranstaltung kann in unterschiedlichen Formaten (synchron, asynchron, hybrid) stattfinden. Unterstützt wird diese durch einen Moodle-Kurs. Die Studierenden erhalten eine Reihe von Materialien, die ihnen die Lerninhalte vermitteln. Es erfolgt Input (z.B. 20-minütige Videoclips), in denen ihnen vorlesungsartig zentrale Erkenntnisse präsentiert werden. Daneben haben sie zweitens die Möglichkeit, in interaktiven Formaten die Lerninhalte zu intensivieren und Bezüge zum berufspraktischen Alltag herzustellen.

Media:
Präsentationen, textbasierte Arbeitsmaterialien, interaktive computergestützte Elemente

Reading List:
Coolican, H. (2019). Research methods and statistics in psychology (seventh edition). Routledge.
Smith, E. R., Mackie, D. M., & Claypool, H. M. (2019). Social psychology (fourth edition). Routledge Taylor & Francis Group.

Responsible for Module:
Holzberger, Doris; Prof. Dr. phil. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Psychology and Human Behavior (Vorlesung, 2 SWS)
Munk S, Holzberger D
For further information in this module, please click campus.tum.de or here.

Module Description

SOT10080: Introduction to Judgement and Decision Making | Introduction to Judgement and Decision Making [JDM]

Introduction to Judgement and Decision Making

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
Students will be evaluated based on a final written examination delivered on moodle, which will assess students' understanding of the theoretical aspects of the course and their ability to think critically and use primary source materials to build novel arguments. Students will be allowed to use their notes during the examination. It will be a coursework (pass/fail assessment).

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
English language fluency

Content:
1) How do we make decisions? Introduction to judgement and decision theory;
2) How can we measure and study decision making?;
3) Normative theories of judgement and choice (subjective probability, subjective utility, preferences, bayes rule, decision making under risk and uncertainty);
4) Descriptive theories of judgement and choice: Biases and heuristics;
5) A tale of two systems (fast and slow thinking) ;
6) Decisions from experience vs. description;
7) Intertemporal choices, influences of attention and memory on decision making, multi-alternative choice;
8) Computational rationality and bounded optimality;
9) Perception of risk and individual differences;
10) Choice architecture: nudging and boosting;
11) The social psychology of decision making;

12) Group decision making;

Intended Learning Outcomes:
The module will provide an overview of the field of judgement and decision making, outline the dominant theoretical approaches, and present the main empirical findings. By the end of the module, students will understand the processes through which humans weigh options and make choices under risk and uncertainty, and how these processes may lead people to diverge from the normative solutions suggested by formal decision theories, for better or for worse. Participation in the module will encourange students to reflect on the ways in which they can apply this theoretical knowledge about decision science to various fields (e.g., use of nudges/boosts in education policy, medicine, finance) and the potential difficulties and pitfalls of taking decision science outside the lab. Ultimately, the students will be encouraged to reflect on how they can use the information provided to become better decision makers in their personal and future professional lives.

Teaching and Learning Methods:
The course will contain 6 seminars taking the format of interactive workshops, interleaved with asynchronous video lectures and individual assignments. The first part of the seminars will take the form of a lecture and will convey key concepts in the field of judgement and decision making, provide a brief historical overview and the present main methodologies employed. The second part of each seminar will be a highly interactive workshop and will guide students through research topics and questions in judgement and decision science, offering demonstrations (e.g. via participation in in-class experiments and surveys), and will highlight experimental findings from psychology and behavioral economics. Some of the asynchronous video lectures and workshops will include invited speakers who are experts in the topic covered. Students will be engaged in group discussions on the applied implications of the research findings.

Media:
Power point lecture presentations; educational videos (asynchronous lectures); interactive computer demonstrations

Reading List:
For each seminar, one or two journal articles (canonical papers or articles which detail applications of the theoretical content covered in the lecture) will be provided as background reading. A list of reference books and textbooks will be provided for those who want to delve deeper into the topic, but will not be mandatory.

Responsible for Module:
Ruggeri, Azzurra; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Judgement and Decision Making (Seminar, 4 SWS)
Ruggeri A [L], Ruggeri A, Stanciu O
For further information in this module, please click campus.tum.de or here.

Module Description

SOT10125: The Psychology of Teamwork: Theory and Practice in Organizations | The Psychology of Teamwork: Theory and Practice in Organizations

Version of module description: Gültig ab summerterm 2025

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

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

Description of Examination Method:
Im Seminar wird eine Studienleistung erbracht (bestanden/nicht bestanden). Um das Seminar zu bestehen, müssen die Studierenden aktiv teilnehmen, d. h. das zugewiesene Material lesen und es in Form von reflektierenden Diskussionen und eigenständigen Präsentationen im Seminar wiedergeben. Neben der Überprüfung des Kenntnisstands hinsichtlich psychologischer Grundbegriffe, Modelle und Studien zielen die Aktivitäten auch auf die Anwendung der Inhalte im beruflichen und alltäglichen Kontext.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
The course offers a deeper focus on psychological theories and perspectives that are integral to organizational contexts and play a key role into how work-based teams or groups form, develop and perform. Further, the seminar explores executive work-based motivational and behavioral theories that are integral to organizational processes.

Intended Learning Outcomes:
Die tiefere Auseinandersetzung mit organisationspsychologischen Konzepten ermöglicht den Studierenden, ein differenzierteres Verständnis dafür zu entwickeln, wie Teams entstehen, funktionieren und arbeiten - und was zu ihrem Erfolg beiträgt.

Teaching and Learning Methods:
Unterstützt wird die Lehrveranstaltung durch einen Moodle-Kurs. Die Studierenden erhalten eine Reihe von Materialien, die ihnen die Lerninhalte vermitteln. Es erfolgt Input der Dozierenden zu zentralen Inhalten des Seminars. Darüber hinaus ist in jeder Sitzung eine kleine Gruppe von Teilnehmern dafür verantwortlich, den zugewiesenen Inhalt zu lesen, zu verstehen und kritisch in einem Präsentationsformat wiederzugeben, das zur Gruppe passt.

Media:
Präsentationen, textbasierte Arbeitsmaterialien, Diskussionen, interaktive computergestützte Elemente

Reading List:
Arnold, j., Randall, R., Patterson, F., Silvester, J., Robertson, I., Cooper, C., Burnes, B., Swailes, S., Harris, D., Axtell, C., & Den Hartog, D. (2010). Work Psychology: Understanding Human Behavior in the Workplace.
Coolican, H. (2019). Research methods and statistics in psychology (seventh ed.). Routledge, Taylor & Francis Group.
Greenberg, J. (2011). Behavior in Organizations. Pearson. https://books.google.de/books?id=OL-8cQAACAAJ
Jex, S. M., & Britt, T. W. (2014). Organizational psychology: A scientist-practitioner approach. John Wiley & Sons.
Peeters, M., De Jonge, J., & Taris, T. (2014). An introduction to contemporary work psychology. Wiley Online Library.
Smith, E. R., Mackie, D. M., & Claypool, H. M. (2019). Social psychology (fourth ed.). Psychology Press.

Responsible for Module:
Holzberger, Doris; Prof. Dr. phil. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
The Psychology of Teamwork: Theory and Practice in Organizations (Seminar, 2 SWS)
Holzberger D, Mitsostergios G
For further information in this module, please click campus.tum.de or here.

Module Description

SOT10139: Critical Thinking: Journal Club | Kritisches Denken: Lesegruppe [CT:JC]

Critical Thinking: Journal Club

Version of module description: Gültig ab winterterm 2025/26

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** irregularly
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 90	**Contact Hours:** 30

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

Description of Examination Method:
The course will be graded on a pass/fail basis. The evaluation of this course will be based on the preparation of a portfolio.
Part 1 - Sustained and active in-class participation with includes submitting concise written reflections prior to each session.
Part 2 - Group Project: in groups of 3/4, students will select and present to the class a topic or reading of their choice. This presentation will be followed by the submission of a written summary of the ensuing discussion, which will serve as the final assignment for the course.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
English language fluency

Content:
Students will read and discuss academic papers and practice critical analysis of contrasting sources. In later sessions, the focus shifts to applied critical thinking (e.g., fake news) group-led sessions on self-chosen topics. Topic suggestions: what is critique, intellectual humility, the development of a critical mind, biases, fake news, Interventions against fake news.

Intended Learning Outcomes:
Students will cultivate the ability to critically analyze both academic and non-academic texts, formulate thoughtful and well-reasoned questions, and reflect on their own reasoning as well as that of others. Throughout the course, they will practice identifying biases, evaluating evidence, and comparing contrasting perspectives. By the end of the course, students will be equipped to

apply critical thinking techniques to a wide range of materials and to communicate their evaluations effectively in both discussion and writing.

Teaching and Learning Methods:
Each session includes student-led paper presentations followed by interactive group discussions. Students are encouraged to engage critically with the material, formulate insightful questions, and compare diverse perspectives. The final sessions are dedicated to student-selected topics, fostering autonomy and collaborative learning within groups.

Media:
Power point presentations; Video materials; online materials, books. Moodle for sharing of resources and interaction in the forum

Reading List:
Horkheimer, M. (1972). Traditional and critical theory. Critical theory: Selected essays, 188(243), 1-11.

Mani, A., Mullainathan, S., Shafir, E., & Zhao, J. (2013). Poverty impedes cognitive function. science, 341(6149), 976-980.

Zmigrod, L., Zmigrod, S., Rentfrow, P. J., & Robbins, T. W. (2019). The psychological roots of intellectual humility: The role of intelligence and cognitive flexibility. Personality and Individual Differences, 141, 200-208.

Responsible for Module:
Serko, Daniil; M.Sc.

Courses (Type of course, Weekly hours per semester), Instructor:
Critical Thinking Reading Group (Vorlesung, 2 SWS)
Serko D [L], Schlingloff-Nemecz L, Serko D
For further information in this module, please click campus.tum.de or here.

Module Description

MH160036: Children, Well-Being, and Digital Technologies | Children, Well-Being, and Digital Technologies

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 90	**Contact Hours:** 90

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

Description of Examination Method:
Project work
• (20%) Begin the seminar with an initial presentation designed to spark conversation, then lead (or co-lead) a 90-minute discussion that challenges you to structure a dynamic learning session and engage participants around a specific issue or topic.
• (65%) Written document. Write a document that outlines a research idea, including its objectives, significance, methodology, questions, and expected outcomes.
• (15%) Video presentation (20% of Project Work): Produce a 1-minute video that enhances the clarity and persuasiveness of your document, effectively summarizing and highlighting the key elements.

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
Children represent the hope of our future, yet what does it mean to be a child or a young person in today's rapidly evolving digital world? This module explores the multifaceted intersection of children, well-being, and digital technologies, examining how emerging innovations reshape every aspect of young people's lives.

In the lecture, students will engage with a broad range of topics that frame our understanding of youth, well-being, and digital technologies. They will explore how definitions of “children” and “youth” are evolving and what coming of age means amid rapid cultural, social, political, and technological shifts. The lecture will also introduce diverse research methods highlighting different approaches to data collection, analysis, and presentation. Interactive elements such as polls, group discussions, and role-playing activities will ensure that students connect past and present insights with current realities.

Building on the lecture content, the seminar zooms in on artificial intelligence (AI) and its impact on children's lives. Here, students will explore emerging trends such as AI influencers, digital twins, and evolving digital identities. The seminar delves into ethical, methodological, and social questions surrounding AI. With guest instructors from research, policy, and industry enriching the conversation, students will lead discussions and explore the ethical, methodological, and social implications of AI.

In the two workshops, students and instructors will collaborate to bring all these insights together by designing an initial study pitch on youth, well-being, and digital technologies. The first will include hands-on work that encourages creative problem-solving and practical application of learned concepts. Following the first workshop, students will participate in a second two-day (virtual) workshop where they will receive feedback to refine and strengthen their research proposal.

Topics may include:
• Definitions: Explore how the concepts of children and youth and coming of age are evolving.
• Methods: Delve into different research methods — from classic surveys to creative tools like DALL-E — that are redefining how we collect, analyze, and present data.
• Connectivity: Address the digital divide and its implications for access to technology, opportunities, and overall well-being, particularly in under-resourced communities.
• Relationships: Examine how friendships and social bonds are shifting.
• Health: Understand global concepts of well-being and the impact of digital technologies on mental health.
• Learning: Understand the skills needed for the future through AI-enhanced personalized learning and explore how research can be effectively translated into policy and practice.
• Privacy: Explore different concepts of digital privacy and data protection for children.
• Work: Investigate the transformation of traditional career paths in the face of AI-driven job automation.
• Creativity: Rethink what creativity means in a digital age where technology shapes the way we express ourselves.

Intended Learning Outcomes:
At the end of the module — which includes a lecture, a seminar, and a project work — students are able to:
• Analyze the evolving definitions of “children” and “youth” amid rapid societal and technological change while mastering and articulating key concepts and theories related to children, digital technologies, and global well-being frameworks.
• Evaluate how digital innovations have historically shaped — and continue to influence — children's experiences, behaviors, and futures across diverse cultural, social, political, and technological contexts.

• Assess, in addition to digital technologies more broadly, the multifaceted impacts of AI on children, recognizing both its transformative opportunities and potential challenges.
• Identify and compare a range of research methodologies, both qualitative and quantitative, used to study children and digital technologies, and demonstrate your research skills by developing a document (i.e., study pitch) that outlines a research idea, including its objectives, significance, methodology, questions, and expected outcomes.
• Examine how children's engagement connects with digital technologies to concepts such as digital literacy, health literacy, child safety, and ethical AI, while reflecting on the broader ethical and societal implications for education, well-being, and creativity.
• Analyze emerging trends such as AI influencers, digital twins, and evolving digital identities, and their implications for children's development and future opportunities.
• Design and deliver a presentation aimed to spark conversation and either lead or co-lead a 90-minute discussion. Formulate questions and comments to structure a learning session, engaging participants around a specific issue or topic relevant the course.

Teaching and Learning Methods:
This module consists of a weekly lecture (2 SWS), a weekly seminar (2 SWS), and two two-day workshops (2 SWS) to drive forward project work. Each component deepens students' understanding of children, well-being, and digital technologies, while fostering critical thinking, creativity, communication, and collaboration among students.

Lecture
This lecture introduces key concepts and theories at the intersection of children and digital technologies, emphasizing emergent innovations and global well-being frameworks. Designed to foster active engagement, it provides opportunities for discussion and reflection, ensuring that students can critically connect theoretical insights with practical implications.

Seminar
Building on what students learned in the lecture about children, well-being, and digital technologies broadly, this seminar takes a closer look at artificial intelligence (AI) and its impact on children's lives. AI is already significantly shaping childhood by influencing how children learn, interact, or build their identities. Focusing on AI allows us to understand these rapid changes and develop strategies to ensure that digital innovations support children's well-being and future opportunities.

Workshops
Over the course of twice two full days (tentatively: July 14-15; second (virtual) workshop dates TBD), students and instructors will engage in collaborative project work. Together they will develop an initial idea for a study pitch. Following the two-day workshop, students will receive feedback to refine and strengthen their pitch.

Media:

Reading List:
• Cortesi, S., Hasse, A., Lombana-Bermudez, A., Kim, S., & Gasser, U. (2020). Youth and Digital Citizenship+ (Plus): Understanding Skills for a Digital World. Youth and Media, Berkman Klein Center for Internet & Society. http://nrs.harvard.edu/urn-3:HUL.InstRepos:42638976
• Gasser, U. (2019). AI Innovators Should be Listening to Kids. WIRED. https://www.wired.com/story/ai-innovators-should-be-listening-to-kids/
• Furlong, A. (2013). Youth studies: An introduction, Routledge. Read chapter 1, Youth and the Life of Course, pp. 1-23.
• Hasse, A., Cortesi, S., & Gasser, U. (2022). Transforming state of the art offline approaches for the digital world: A methods guide for youth and well-being focus groups. Youth and Media, Berkman Klein Center for Internet & Society. https://nrs.harvard.edu/URN-3:HUL.INSTREPOS:37373988
• Hasse, A., Cortesi, S., Lombana-Bermudez, A., & Gasser, U. (2019). Youth and artificial intelligence: Where we stand. Berkman Klein Center for Internet &; Society at Harvard University. http://nrs.harvard.edu/urn-3:HUL.InstRepos:40268058
• Madden, M., Calvin, A., Hasse, A., & Lenhart, A. (2024). The dawn of the AI era: Teens, parents, and the adoption of generative AI at home and school. San Francisco, CA: Common Sense. www.commonsensemedia.org/sites/default/files/research/report/2024-the-dawn-of-the-ai-era_final-release-for-web.pdf
• Waller, G., Süss, D., Suter, L., Willemse, I., Külling, C., Bernath, J., Skirgaila, P., Löpfe, S. (2021). JAMESfocus – Looking Back on a Decade of Youth Media Research. Zürich: Zurich University of Applied Sciences. https://www.zhaw.ch/storage/psychologie/upload/forschung/medienpsychologie/james/jamesfocus/2022/JAMESfocus_Jugendmedienforschung_EN.pdf

Responsible for Module:
Cortesi, Sandra; Prof. Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Children, Well-Being, and Digital Technologies (Vorlesung, 2 SWS)
Cortesi S, Hidalgo Avila C

Workshop: Children, Well-Being, and Digital Technologies (Übung, 2 SWS)
Cortesi S, Hidalgo Avila C

Seminar to Children, Well-Being, and Digital Technologies (Seminar, 2 SWS)
Cortesi S, Hidalgo Avila C
For further information in this module, please click campus.tum.de or here.

Module Description

MH160037: Lost in Translation? Transforming Research into Policy and Practice | Lost in Translation? Transforming Research into Policy and Practice

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 150	**Contact Hours:** 30

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

Description of Examination Method:
Project work. The project work is assessed through two main components: A “creative submission” and a presentation.

Creative Submission (90% of overall grade)
• Creation (80%): Develop a creative representation of research using text, visuals, audio, or multimedia formats. Your submission must be based on a dataset and demonstrate your ability to present complex information in an engaging, accessible manner. Students are free to choose the medium that best represents their idea. Examples may include: A research paper or policy brief, poster or collage, data visualization, animation, video, podcast, comic, workshop, game, exhibition or installation, or interactive website.
• Written explanation (20%): Provide a brief written explanation of your design choices, outlining how your creative submission effectively communicates the research.

Presentation (10% of overall grade)
• Showcase your creative submission during a peer-feedback session. This presentation is an opportunity to engage with your peers by exchanging insights and receiving constructive critiques.

Weighting factor: Creative submission (90%): Actual creation (80%) and written explanation (20%). Presentation (10%).

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
Research holds the potential to shape formal (such as strategies, laws, and regulations) and informal (such as unwritten norms and internal procedures) policy (i.e., principles, guidelines, or rules designed to influence and guide decision-making within governments, organizations, or institutions) and influence real-world change, yet transforming research into actionable policy and practice is complex.

In this bi-weekly seminar, students will explore the intricate relationship between research, policy, and practice, identifying both opportunities and challenges in making research impactful. Through case studies, group discussions, and hands-on exercises, students will examine how diverse stakeholders — from policymakers and industry leaders to advocates and the public — engage with research, and how various formats and creative outputs can enhance its reach and influence. Students will critically debate different dimensions of evidence-based policymaking, analyzing both its successes and shortcomings. Building on these explorations, students will work directly with researchers, policymakers, and practitioners to develop the skills needed for making research resonate within and beyond academia. Reflecting on their own roles in bridging the research-to-policy-to-practice gap, students will be equipped to thoughtfully contribute to policy discussions and navigate the challenges of applying evidence in real-world contexts.

Topics may include:
• Mapping the research-policy-practice journey: Understand the full policy cycle — from agenda-setting to implementation — and how each stage influences the translation of research into policy and practice.
• Bridging Research and Practice: Explore how research informs both formal and informal policy.
• Overcoming barriers: Identify the challenges in converting research into policy and practice — including financial and capacity limitations, institutional issues, temporal misalignment, communication and cultural barriers, and stakeholder conflicts and political pressures — and examine strategies to overcome these obstacles.
• Creative communication: Learn how to design creative formats and outputs that effectively showcase research.
• Tailoring for diverse audiences: Adapt formats and outputs for various stakeholders — from academic peers, to policymakers, industry leaders, and the public.
• Stakeholder engagement: Understand the roles and perspectives of key actors in the policy ecosystem, and learn how to foster meaningful collaboration between researchers and decision-makers.

Intended Learning Outcomes:
Participation in this module — which includes a seminar and self-directed project work — will allow students to explore the journey from research to policy to practice. By the end of this seminar, students will be able to:
• Understand the relationship between research, policy development, and implementation, and identify key opportunities and challenges in translating research into actionable outcomes.

• Differentiate among the needs of diverse stakeholders (e.g., policymakers, industry leaders, advocates, and the public) and evaluate how various communication formats enhance the impact and reach of research findings.
• Reflect on personal roles in bridging the research-to-practice gap and develop the skills to effectively translate research into accessible, engaging formats.
• Gain diverse perspectives on knowledge translation through the active engagement with researchers, policymakers, and practitioners.
• Understand the methodological, ethical, and political dimensions of integrating research into policy and practice by analyzing both successful and problematic cases of evidence-based policymaking.
• Propose innovative strategies that improve the translation of research into policy and practice by applying the insights learned in the seminar.

Teaching and Learning Methods:
Seminar (2 SWS)
This seminar is designed to be highly interactive and unfolds over eight sessions throughout the semester. Through a mix of case studies, group discussions, tutorials, creative activities, and hands-on exercises, students will apply theoretical insights to the real-world challenges of translating research into policy and practice. Guest speakers — researchers, policymakers, and practitioners — will offer diverse perspectives and encourage dialogue, enriching the learning experience. Continuous guided reflections will encourage students to critically assess their learning process, refine their ideas, and build the practical skills needed to translate research into meaningful policy and practice

Media:

Reading List:
• Ashar, A., Faris, R., & Gasser, U. (2016). Networked policy making avenues: Assessing the role of academics in digital policy (Networked Policy Series, Berkman Klein Center Research Publication No. 2016-14). SSRN. http://ssrn.com/abstract=2842796
• Thaler, R. & Sunstein, S. (2008). Nudge: Improving Decisions about Health, Wealth, and Happiness, New Haven: Yale University Press, Introduction, pp. 1-14.
• Langdon Winner (1986). “Do Artifacts Have Politics?” In: The Whale and the Reactor: A Search for Limits in an Age of High Technology. Chicago, IL: University of Chicago Press. Chap. 2, pp. 19–39.
• Tactical Tech. (n.d.) The Glass Room. https://theglassroom.org/
• Zagoruichyk A. (2023, October 18). Picturing the Invisible: Interview with Makoto Takashashi. Anthrosphere, The Oxford Climate Review. https://www.anthroposphere.co.uk/post/picturing-the-invisible-interview-with-makoto-takahashi

Responsible for Module:
Cortesi, Sandra; Prof. Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Lost in Translation? Transforming Research into Policy and Practice (Seminar, 2 SWS)
Cortesi S, Hidalgo Avila C
For further information in this module, please click campus.tum.de or here.

Module Description

POL10500: Comparative Politics - Fundamentals | Comparative Politics - Fundamentals

Version of module description: Gültig ab winterterm 2025/26

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

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

Description of Examination Method:
The module examination is a written test.
Students' achievement of the intended learning outcomes will be assessed through a 90-minute multiple-choice examination of 50 questions. With the written test, students demonstrate their ability to identify key terms and theories in comparative politics and describe structural elements of political systems. They also show that they can analyze key determinants of regime stability and regime change, clarify how and why political institutions vary, assess their effects in different contexts, evaluate political processes, and design research projects in comparative politics.
The exam is designed to evaluate theoretical knowledge and practical application. Approximately 70% of the questions will assess students' understanding of key concepts, theories, research design, and empirical findings covered in lectures and readings. The remaining 30% will test the application of knowledge gained through practical exercises conducted in seminars, ensuring that students can engage with comparative political analysis beyond memorization. The multiple-choice format allows for a broad assessment of learning outcomes while maintaining objectivity and efficiency. To ensure a fair and comprehensive evaluation, the exam will be structured to balance recall, comprehension, and applied reasoning, reflecting the module's emphasis on theoretical foundations and analytical skills.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
This module explores fundamental questions in comparative politics, such as: What distinguishes democratic from non-democratic regimes? Why do some countries democratize while others do not? Does economic growth lead to democracy? Do democracies perform better than non-democratic regimes in providing public goods?

The module is structured into three parts:
- Foundations of Comparative Politics – Covers core theoretical principles, research design, and methodological approaches in political science.
- State Formation and Political Systems – Examines state-building processes, different political system types, and their structures and institutions, with a particular focus on democracies and dictatorships.
- Political Actors and Institutions – Analyzes key institutional and actor-specific dynamics, including political parties, interest groups, and social movements.

Intended Learning Outcomes:
By the end of this module, students will be able to:
- Recognize and define key terms, concepts, and theories in comparative politics.
- Design research projects in comparative politics and apply basic scientific methods of comparative analysis.
- Identify and describe structural elements of political systems and classify different types of government based on key criteria.
- Analyze the key determinants of regime stability and regime change, explaining how and why political institutions vary and assessing their effects in different contexts.
- Compare and evaluate competing theories to explain political events, justifying why one theory may offer a better explanation than another.
- Assess political processes using different evaluation criteria across various contexts.
- Develop and support well-reasoned answers to questions about political institutions by drawing on relevant literature and empirical evidence.

Teaching and Learning Methods:
The module employs a combination of lectures, exercises to facilitate both theoretical understanding and practical application.

- Lectures introduce key concepts, theories, research designs, and methods of comparative politics, using real-world examples to illustrate their application.
- Exercises provide opportunities to deepen and extend this knowledge through individual and collaborative hands-on activities, applied case studies, and problem-solving tasks.
- Discussions and reflections encourage students to critically engage with the material, analyze different perspectives, and articulate their understanding through structured debate and commentary.

- Practical applications allow students to apply theoretical knowledge to concrete political scenarios, reinforcing learning through interactive problem-solving and case-based exercises.

Media:
Power Point

Reading List:
'• Newton, K. & van Deth, J. W. (2021). Foundations of Comparative Politics (Fourth Edition). Cambridge: Cambridge University Press.
• Adams, K.A. & Lawrence, E.K. (2018). Research Methods, Statistics, and Applications (2nd Edition). London: Sage
• Kellstedt, P.M. & Whitten, G.D. (2018). The Fundamentals of Political Science Research (3rd Edition). Cambridge: Cambridge University Press.
• Boix, C. & Stokers, S. (2009). The Oxford Handbook of Comparative Politics. Oxford: Oxford University Press.
• Lijphart, A. (2012). Patterns of Democracy: Government Forms and Performance in Thirty-Six Countries (Second Edition). New Haven: Yale University Press.
• King, G., Keohane, R. & Verba, S.(1994) Designing Social Inquiry: Scientific Inference in Qualitative Research. Princeton: Princeton University Press.
• Brady, H.E. & Collier, D. (2004) Rethinking Social Inquiry: Diverse Tools, Shared Standards. Oxford: Rowman and Littlefield.
• Clark, W. R., Golder,M. & Golder, S. M. (2017). Principles of Comparative Politics (Third Edition). (Washington DC: SAGE Publications)
• Caramani, D. (2020) Comparative Politics (Fifth Edition). Oxford: Oxford University Press
• Przeworski, A. (2019). Crises of Democracy. Cambridge: Cambridge University Press
• Toshkov, D. (2016). Research Design in Political Science. London: Palgrave.

Responsible for Module:
Theocharis, Ioannis; Prof. Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
(POL10500) Fundamentals of Comparative Politics (Exercise) (Übung, 2 SWS)
Pradel-Sinaci F, Theocharis I

(POL10500) Fundamentals of Comparative Politics (Lecture) (Vorlesung, 2 SWS)
Theocharis I
For further information in this module, please click campus.tum.de or here.

Module Description

POL60102: Science Communication and Public Engagement | Science Communication and Public Engagement

Version of module description: Gültig ab winterterm 2025/26

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

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

Description of Examination Method:
The module examination is a presentation which is supplemented by a short written elaboration. The presentation consists of an individual or group presentation on a new format idea in the field of science communication. With the presentation (approx. 20 minutes) and discussions in the classroom the students demonstrate that they understand the practical aspects of format prototyping for science communication and public engagement as well as that they have grasped the major concepts and can explain them and react to questions. With the written summary (1-2 pages) of the presentation, students show that they are able to present the concept they have developed for the presentation in a structured and comprehensible way.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
1) Introduction to science communication and public engagement: The growing role of science communication for universities and research organizations, the main actors and topics of science communication; Goals, target groups and formats; participatory science communication and public engagement
2) Learn the practical aspects by developing your own format of science communication: Specify content, define target group/personas and design a digital format or event. We will work with practitioners and follow the new TUM format prototyping handbook that was developed during the last semester.

Intended Learning Outcomes:
After the successful completion of the class „Science communication and Public Engagement“, the students understand the basic concepts of science communication. They have an overview of media, platforms and formats and understand how to address specific target groups. They know the basic concepts of digital format prototyping and have themselves developed a new format.

Teaching and Learning Methods:
The module consists of a seminar with integrated exercises. Together with digital format experts the students will develop a format prototyping manual. With the help of the manual, they will develop and propose own ideas which can cover a broad range of media formats (videos, podcasts, social media channels etc.) and public engagement formats (slams, festivals, citizen science, etc.). By presenting these format ideas, the students will train to talk and reflect about specific methods of science communication. In class discussions they will broaden their knowledge on communicating science in an increasingly fragmented media world.

Media:
Assigned readings, presentations, discussions

Reading List:
Göpfert Winfried, Wissenschafts-Journalismus: ein Handbuch für Ausbildung und Praxis, 6., überarbeitete und aktualisierte Auflage, 2019, https://doi-org.eaccess.tum.edu/10.1007/978-3-658-17884-0
Meredith, Dennis, Explaining Research: How to Reach Key Audiences to Advance Your Network, 2nd edn (2021; online edn, Oxford Academic, 19 Aug. 2021), https://doi-org.eaccess.tum.edu/10.1093/oso/9780197571316.001.0001, accessed 10 Mar. 2024.
Bertemes, Jean Paul, Haan Serge and Hans, Dirk. 50 Essentials on Science Communication, Berlin: De Gruyter Mouton, 2024 https://doi-org.eaccess.tum.edu/10.1515/9783110763577

Responsible for Module:
Rubner, Jeanne; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
(POL60102) Science Communication and Public Engagement (Seminar, 2 SWS)
Rubner J
For further information in this module, please click campus.tum.de or here.

Module Description

SOT46402: Society and Technology | Society and Technology

Version of module description: Gültig ab winterterm 2024/25

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 module examination is a 60min written exam, which takes place in the last session of the semester. The format of a written exam gives students the opportunity to demonstrate their ability to recall knowledge about the societal dimensions of data infrastructure and basic social science approaches in 5 closed questions. The 3 open questions in the examination give the students the opportunity to transfer and apply their knowledge and illustrate they are able to assess the societal dimensions of data infrastructure, evaluate their benefits, safety requirements and social impacts. Additionally, they can showcase their ability to transfer their knowledge on basic social science approaches for analyzing data structures to selected examples, demonstrate their ability to assess their societal impact and to reflect on methodological choice and empirical findings in a critical but constructive way and finally to independently draw conclusions.
The format further enables to test the recall of social science epistemology and fundamentals of qualitative methods. To conclude, the students can demonstrate their ability to apply the above concepts on novel examples.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The module will be taught in two lectures. The first lecture seeks to open the so-called black box of the ‘society’ of data infrastructures. It focuses on the societal, political and cultural dimensions of data production and governance. To this end, the module introduces social science approaches and basic concepts such as responsibility, risk, safety, infrastructure, innovation, and societal trust. It addresses topics such as how data are societally embedded, inscribed by underlying cultural values and governed by rules and result in un-intended consequences. We will discuss

distinct societal implications of technical trajectories, long-term as well as short-term benefits, and risks of the data-fiction of societies (including implications for vulnerability and resilience as well as inequalities and justice. We unpack institutional & cultural drivers of techno-change as well as varieties of societal pathways how to govern data and ways how to gain trust in institutions (science, administration), which are responsible for the assessment and management of data. Based on these findings, we explore the range of options for how technologies can be best governed: by whom, to what ends, by what means, and with what welfare consequences for affected groups.
The module also introduces into approaches of interdisciplinary technology assessment (Technology Assessment, Responsible Research and Innovation, Anticipatory Governance, living labs). We apply concepts of the lectures to possible fields of application such Extreme Events, Climate services, AI, Critical Infrastructure, Consumer Protection, Security, Climate Engineering, Carbon Removal Technologies and illustrate societal causes and impacts with examples of TUM research.
The second part of the module students learn how the qualitative social sciences know and analyze social dynamics, society, and social order. Students will be introduced to social science epistemology: How do explaining and interpreting differ? What does understanding someone really mean? What drives societal development? They will understand how 'the social' differs from 'society' and 'social order' by way of addressing selected social theories and their underlying ontologies. Last but not least, the course turns towards crucial qualitative methods so that students get a first grasp of how society and 'the social' can be known in different ways and what the consequences of these differences are.

Intended Learning Outcomes:
After successfully completing module, students can assess the societal dimensions of data infrastructure, evaluate their benefits, safety requirements and social impacts. They have the competence to apply basic social science approaches to analyze data structure in a targeted manner to the analysis of selected cases (e.g. critical infrastructures, health), to assess societal impacts and causes respective risks, and to develop responsible solutions. They have competencies to reflect methodological choices and empirical findings in a critical, but constructive way.
They will further know the basics of social science epistemology and have gained an understanding of social theories and their underlying ontologies.

Teaching and Learning Methods:
The module takes place in the form of two lectures (including video presentations), student presentations and single and group exercises. In the lecture, PowerPoint presentations are used to explain the basics of societal assessment and management.
During lectures, the content of teaching is disseminated by way of talks or presentations. Tablet PCs are used to derive and illustrate complex issues. In the course of the lectures, explicit questions are raised which call for transfer capabilities on the part of students while giving them the opportunity to speak up and discuss potential solution concepts. This approach is aimed at providing deeper insights into societal risk and their safety challenges, thus simultaneously fostering a transfer of the acquired know-how to other problem areas. It further serves to build a

better understanding of social science epistemology and how to utilize it and lay the groundwork for qualitative methods and their application.
The module is oriented to towards concrete societal impacts of data infrastructure which are used as examples to apply and improve their social science skills. Group work and other interactive formats are used to enable a critical discussion of the learning content and outcomes, to apply it to selected fields and to draw evidence-based conclusions.

Media:
PowerPoint, Video, Poster, break-out groups, Scenario-Building, Flipchart

Reading List:
Bowker, G. C., Baker, K., Millerand, F., & Ribes, D. (2010). Toward information infrastructure studies: Ways of knowing in a networked environment. International handbook of internet research, 97-117.
Marres, N. (2017). Digital sociology: The reinvention of social research. John Wiley & Sons.

Responsible for Module:

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

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

Module Description

SOT56307: Philosophy of Artificial Intelligence: Key Readings | Philosophie der Künstlichen Intelligenz: Schlüsseltexte

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor/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 an oral examination (30 minutes), students will demonstrate their ability to interpret philosophical texts on AI topics and discuss their approaches in relation to current debates.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Can machines learn and think? How do AI systems differ from human thought, speech, and action? How is AI changing knowledge and science? What are the ethical risks? And how should the basic assumptions of AI research and development be considered? Assigned courses address AI-related topics from a variety of philosophical perspectives, including logic, philosophy of language, philosophy of mind, knowledge, and science, philosophical anthropology and ethics.

Intended Learning Outcomes:
Students are able to,
- understand texts on philosophical issues in the context of artificial intelligence
- identify and exemplify philosophical concepts relevant to AI phenomena
- apply philosophical concepts to discuss current AI phenomena (selected examples).

Teaching and Learning Methods:
Seminar: readings and discussions of texts including teaching on historical and philosophical contexts and discussions to argue their relevance for current debates.

Media:
Online Reader

Reading List:
Margaret A. Boden (Ed.): The Philosophy of Artificial Intelligence, Oxford 1990

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Philosophy of Artificial Intelligence. Classical Readings in the Phenomenology of AI (Seminar, 3 SWS)
Centrone S
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86072: Project Week: Application Project: Public Sector | Project Week: Application Project: Public Sector

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
Students will be assessed based on their project work, making up 50% of their grade, and an accompanying 30min presentation, making up 50% of their grade. The project work will be assessed with a 10 page report. In the first phase of the project students can demonstrate their ability to research and analyze current public sector projects as well as their skill to evaluate and identify gaps in political engagement. In the second stage of the project students demonstrate their ability to develop and implement novel methods for political engagement incorporating different disciplines. The presentation will examine the students ability to present their work to expert groups.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
In this project-oriented module, students will work in interdisciplinary teams alongside staff from public administration and government entities. By researching and analyzing current public sector projects, students will identify gaps and devise novel methods for political engagement. They will present and discuss their ideas with peers, public officials, learning how to successfully realize their proposals and create impactful projects for social purposes in interdisciplinary teams. The primary goal of the module is to actively create new methods to support and enhance public sector innovation for various groups. Students will develop their ideas independently and then discuss their potential projects with representatives of public instiutions. After completion the resulting projects will be ready and fit to be used by the public sector for enhancing digital participation and democratic engagement.

The module acts as a bridge between public sector entities and TUM, supporting the development of new digital participation opportunities and the interdisciplinary integration of technical implementation, governance perspectives, and societal needs concerning digital participation. The students will be working together on projects through a holistic, interdisciplinary approach to enhance digital participation and democratic engagement, thus strengthening democracy. At the end of the seminar, students will be capable of designing and implementing projects while incorporating different disciplines.

Intended Learning Outcomes:
After successful completion students are able to: research and analyze current public sector projects, evaluate and identify gaps in, and devise novel methods for, political engagement. Additionally they can design and implement projects while incorporating different disciplines.

Teaching and Learning Methods:
The module will take place in seminars, in which the stundes will be able to work together in interdiscipinary teams to jointly develop and implement novel projects while receiving feedback and guidance from their peers, lecturers and public sector entities.

Media:
PowerPoint

Reading List:
Noveck, B. S. (2021). Solving public problems: a practical guide to fix our government and change our world. Yale University Press.

Responsible for Module:
Pfeffer, Jürgen; Prof. Dr. rer. soc. oec.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86072) Application Project: Public Sector (Project Week) (Seminar, 4 SWS)
Pfeffer J, Schröder J
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86079: History and/of Technology | History and/of Technology

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
This module will be examined with a 60min written exam. This format allows the students to demonstrate their ability to explain the role history and its implications play for the present and future, with a focus on the history of genocide and the holocaust. It will further give students the opportunity to demonstrate their knowledge on how the history of genocide and the holocaust has been used as a tool to advocate for a different present and future, and which role technology plays. Students ability to translate their knowledge to the current multiethnic and immigration society as well as to populist tendencies is tested as well.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The history of mankind is a history of struggle for human rights. The 20th century is closely connected with the worst experiences of war, genocide and violence in human history, at the same time it brought about democracy, times of peace, equality and prosperity. Towards the end of the 20th century history – esp. the history of genocide & the holocaust – became a creative and powerful tool to advocate for a different present and future. Which role do the history of war and genocide play today, in a time deeply shaken by polycrises and an uncertain future? Can a history of human achievements (such as overcoming war and violence), technological innovation and democratic politics contribute to a culture of confidence and hope?

Intended Learning Outcomes:
After successfully completing the module, students will be able to:
- Understand and recall how history, specifically history of genocide and the holocaust, was used as a tool to influence current and future events
- Critically assess and analyze the role technology has, and continues to play
- Analyze the role of memory in a multiethnic and immigration society and in times of populism
- And utilize their gained knowledge to defend democracy

Teaching and Learning Methods:
The module will be taught in lectures in a hybrid format. The lecture format combined with in class discussions will provide the ideal learning environment to teach students the fundamentals of how history can impact current and future prospects.

Media:
PowerPoint

Reading List:
Zadoff, M. (2023). Gewalt und Gedächtnis: Globale Erinnerung im 21. Jahrhundert. Carl Hanser.

Responsible for Module:
Zadoff, Mirjam; Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86079) History and/of Technology (Seminar, 4 SWS)
Zadoff M
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86080: Risk & Crisis Communication (6 ECTS) | Risk & Crisis Communication (6 ECTS)

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The module will be assessed through a case study report of 10-15 pages, which will make up 80% of the grade and a 20 minute presentation which makes up the remaining 20%.
The case study report allows the students to demonstrate their ability to determine what constitutes a crisis, that they understand the key concepts and theories in risk and crisis communication and that they know of the typical stages of a crisis. They are further able to highlight their knowledge of the intersection of communication strategies, political decision-making and public attitudes. Within the report students will also critically assess the communication practices utilized in their given topic. In their presentation students will demonstrate their ability to communicate scientific findings to an academic audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
An interest in leaning about different theories and scenarios of risk and crisis communication as well as social science research.

Content:
The module consists of a lecture and a seminar. The lecture introduces the theoretical foundations and practical applications of risk and crisis communication from a social science perspective. It delves into how communication strategies are developed and executed in times of crisis, the role of media, the impact of political decisions, and the psychological aspects of risk perception. This also includes the different stages of the crisis management process, including precrisis (prevention, preparation, planning), crisis response (crisis communications and stakeholder engagement), and

postcrisis (lessons learned, corrective actions and reputation recovery). During the lecture, there will be slides and presentations, students will answer questions and perform short exercises that help them to better understand the course content. In the seminar, students will apply the learned concepts to a case study. They will form groups, learn how to work as teams, and examine a real-life risk and crisis event. Through a presentation and a project report, they will prove their expertise in risk and crisis communication.

Intended Learning Outcomes:
After successful participation in the module, students will have a comprehensive understanding of risk and crisis communication: what constitutes a crisis, understand key concepts and theories in risk and crisis communication, and typical stages of a crisis. They will have an understanding of the intersection of communication strategies, political decision-making, and public attitudes. They will be equipped to critically assess communication practices of past and recent crises. They will be able to work in teams, to conceptualize, plan and execute a risk and crisis communication case study.

Teaching and Learning Methods:
Lectures, presentations, group work and discussions, assigned readings, film/video screenings. The module consists of a lecture and a seminar. The lecture introduces the theoretical foundations and practical applications of risk and crisis communication from a social science perspective. It delves into how communication strategies are developed and executed in times of crisis, the role of media, the impact of political decisions, and the psychological aspects of risk perception. This also includes the different stages of the crisis management process, including precrisis (prevention, preparation, planning), crisis response (crisis communications and stakeholder engagement), and postcrisis (lessons learned, corrective actions and reputation recovery). During the lecture, there will be slides and presentations, students will answer questions and perform short exercises that help them to better understand the course content. In the seminar, students will apply the learned concepts to a case study. They will form groups, learn how to work as teams, and examine a real-life risk and crisis event. Through a presentation and a project report, they will prove their expertise in risk and crisis communication.

Media:
Computer, presentations, videos

Reading List:

Responsible for Module:
Walter, Stefanie; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86080, SOT86102) Risk & Crisis Communication: Theories and beyond (Vorlesung, 2 SWS)
Walter S

(SOT86080) Risk & Crisis Communication (part of 6 ECTS module) (Seminar, 2 SWS)
Walter S
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86124: Generative Design Studio: Responsible Quantum Innovation | Generative Design Studio: Responsible Quantum Innovation

Version of module description: Gültig ab summerterm 2025

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 135	**Contact Hours:** 45

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

Description of Examination Method:
Students will complete a portfolio of three preparatory exercise sheets (20%), and a semester-long design project for creating a generative design artifact (40%) along with a presentation (20%) and reflective essay (20%).
During the module, one exercise sheet will be submitted about quantum basics, responsible innovation, and generative design respectively. This makes three exercise sheets in total. These exercises demonstrate the students understanding about the core vocabulary and concepts learned in this course, which are to be applied in the following parts of the seminar.
Throughout the semester, students document their design process, participate in consultation sessions for feedback, and refine their concepts. Students independently develop a generative design concept that integrates quantum principles with responsible innovation themes. The course culminates in the submission of a final design artifact accompanied by a presentation and a short reflective essay of around 1,000 words.
The design artifact will take the form of a documented design concept, a prototype, or an implemented design. The design artifact demonstrates the students understanding and transfer of generative thinking and design methods in practice, and communicating complex ideas through data- and design-driven storytelling.
The reflective essay articulates the societal relevance, design rationale, and responsible innovation considerations of their work, demonstrating the ability to critically reflect on the application of generative design principles on the subject of responsible quantum innovation.
The final presentation of the process and results (i.e., the design artifact) will showcase the students understanding of the three explored domains of quantum technology, responsible innovation, and generative design. Students will demonstrate their ability to communicate complex ideas through storytelling, while also critically reflecting on their own process and the subject-matter explored.

Repeat Examination:

(Recommended) Prerequisites:
No prerequisites.
Basic programming skills can be helpful, for example from experience with or classes on JavaScript, Python, HTML/CSS, or even p5.js/Processing.

Content:
The module introduces students to the foundations of quantum technologies and their societal implications through the lens of generative design. It combines basic quantum theory (superposition, entanglement, uncertainty) with principles of generative design, creative coding, and responsible innovation. Students explore how emerging quantum technologies may shape future design challenges, societal developments, and ethical questions.
The module emphasizes speculative design and responsible innovation, encouraging students to critically reflect on the potential applications, risks, and governance challenges of quantum technologies. Students engage with creative coding exercises, data-driven storytelling, and design methods such as ideation frameworks, scenario-building, and prototyping. Throughout the course, students develop individual or collaborative projects that integrate quantum concepts with responsible design approaches, culminating in the creation of speculative design artifacts.
Key topics include:
- Foundations of quantum theory and its differences from classical computing
- Generative design principles: automation, randomness, and rule-based design
- Responsible innovation and societal implications of quantum technologies
- Data as design material and storytelling component
- Speculative futures and scenario development
- Human-machine collaboration and co-creation processes

Intended Learning Outcomes:
After successful participation in the module, students are be able to
- Apply core vocabulary of generative thinking and design methods.
- Communicate complex ideas through data- and design-driven storytelling.
- Explain basic quantum concepts.
- Critically reflect on the societal impact of quantum technologies.

Teaching and Learning Methods:
The module is offered in a studio-based, practice-oriented format that combines seminar and workshop sessions with independent project development. The initial three-day block seminar introduces core theoretical foundations and creative methods through lectures, discussions, coding exercises, and group-based ideation workshops.

Students engage in experiential learning by applying generative design principles and quantum concepts in their own design projects. The course emphasizes iterative experimentation, peer feedback, and reflective practice. Throughout the semester, bi-weekly consultation hours provide structured opportunities for individual guidance, troubleshooting, and formative feedback. Learning takes place through a mix of instructor-led inputs, collaborative exercises, self-directed inquiry, and the development of individual or group design prototypes. The studio format supports active participation, creativity, and critical engagement with the societal implications of quantum technologies.

Media:
PowerPoint, White boards, Literature, Zoom

Reading List:
Key Reading:
Hübner, P. (2025). The Generative Mind. A New Approach to Creative Thinking, niggli, ISBN 978-3-7212-1059-0
Selective Readings from:
Capra, F., Luisi, P. (2014). The Systems View of Life. A Unifying Vision, Cambridge University Press, ISBN 978-1-316-61643-7
Dunne, A., Raby, F. (2013). Speculative Everything. Design, Fiction, and Social Dreaming, MIT Press books, ISBN 978-0-262-019842
Maeda, J. (2019). How to Speak Machine. Laws of Design for a Digital Age, Penguin RandomHouse, ISBN 978-0-241-42214-4
Büscher, B (Hrsg.) (2004). Kaleidoskopien Band 5: Ästhetik als Programm. Max Bense/Daten und Streuungen, Vice Versa, ISBN 3-00-014180-4

Responsible for Module:
Gasser, Urs; Prof. Dr. jur.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86124) Generative Design Studio: Responsible Quantum Innovation (Seminar, 3 SWS)
Gasser U, Marco F, Molnar A, Schönborn S
For further information in this module, please click campus.tum.de or here.

Module Description

LS60021: Places of Change – Education for Sustainable Development Outside the Classroom | Places of Change – Education for Sustainable Development Outside the Classroom

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The module examination takes the form of a project work in which students work in groups to design a specific ESD program, carry it out in practice and then prepare and evaluate it in writing. The project work is divided into the following components: peer feedback during the process of finding ideas (10% of the grade), practical implementation (20% of the grade), written report (approx. 6 - 8 pages, 50% of the grade), written evaluation and reflection (approx. 2 pages, 20% of the grade).

In the course of the module, students work in groups to design an ESD program for a target group of their choice under the guidance of the lecturer and with the help of peer feedback (10% of the grade) and implement it outdoors in an authentic situation. The practical implementation should demonstrate that a technically and didactically sound educational offer for the target group can be developed independently and implemented outdoors. The implementation takes place as a practical group examination, lasting approx. 60 - 90 minutes depending on the size of the group (approx. 15 - 20 minutes per student, 20% of the grade). Subsequently, students are expected to prepare a written report (approx. 6 - 8 pages, 50% of the grade) on their ESD education program. The individual achievements of each student are to be marked in the report. In addition to the methodological and didactic implementation, the report should address the theoretical background and scientific findings and classify the student's own ESD offer in the context of sustainable development. In addition, the report should be followed by a written critical reflection and evaluation (approx. 1 - 2 pages, 20% of the grade) of the implemented ESD offer.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Participants should be willing to participate in outdoor lessons in various weather conditions during the winter semester. Basic knowledge and/or studies related to sustainability are an advantage, but not a prerequisite.

Content:
ESD means education for sustainable development. Development is sustainable when people worldwide, now and in the future, can live with dignity and develop their needs and talents while taking planetary boundaries into account. Such a social transformation requires strong institutions, participatory decisions and conflict resolution, knowledge, technologies and new behavioral patterns. ESD should enable people to reflect on the impact of their own actions on the world and to make responsible, sustainable decisions. (© BMBF)

The following contents and methods are part of the module:

- Education for Sustainable Development (ESD)
- Education Outside the Classroom
- Environmental Education, Global Learning, Transformative Learning
- Socio-Ecological Transformation
- Whole Institution Approach
- Resilience as a future skill
- Philosophical conversation as an ESD-method
- Human-nature-relationship
- Inclusion of Nature in Self Scale (INS-Scale) as a method to measure connectedness to nature
- LandArt and other types of active nature experiences

Intended Learning Outcomes:
After successfully completing the module, participants will be able to:
1. identify places of change that are suitable for Education for Sustainable Development (ESD) and outdoor education programs
2. understand the concept of the Whole Institution Approach
3. use the INS scale to measure closeness to nature and evaluate its role in sustainable action
4. implement ESD and outdoor education methods themselves with a target group
5. assess the role of ESD and outdoor education in the context of sustainable development
6. develop ESD and outdoor education programs for different target groups

Teaching and Learning Methods:
The interdisciplinary module is in its format as a project interactive and combines various learning methods. The content of the lessons is mainly actively developed, illustrated and deepened by the students in the form of presentations, group work, peer- feedback and discussions. Individual presentations by the teacher serve primarily to impart basic knowledge in the field of education for sustainable development. In the group work and discussions, the content, some of which has been prepared by students themselves, is deepened, critically examined and presented. The knowledge gained is put directly into practice within the module by students working in teams under guidance

of the teachers and by means of peer-feedback to develop an ESD offer for a target group of their choice and putting this into practice outside on site.

Media:
PowerPoint, flipcharts, films, virtual exchange in Zoom

Reading List:
BAIER, A.; MÜLLER, C.; WERNER, K. (2024): Unterwegs in die Stadt der Zukunft. Urbane Gärten als Orte der Transformation. transcript Verlag, Bielefeld
CORNELL, J. (2006): Mit Cornell die Natur erleben. Verlag an der Ruhr. Mühlheim
GEBHARD, U. (2020): Kind und Natur. Die Bedeutung der Natur für die psychische Entwicklung. 5. Aufl., Springer VS, Wiesbaden.
GEBHARD, U.; LUDE, A.; MÖLLER, A.; MOORMANN, A. (2021): Naturerfahrung und Bildung. Springer VS, Wiesbaden.
KOEDELPETER, T.; KREUZINGER, S.; SCHLEHUFER, A. (2022): Wandel braucht Bildung. Impusle, Konzepte und Praxis zur Bildung für nachhaltige Entwicklung. oekom Verlag, München.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Places of Change – Education for Sustainable Development Outside the Classroom (Projekt, 3 SWS)
Endriß T
For further information in this module, please click campus.tum.de or here.

Module Description

POL23200: Environmental Politics in International Comparison | Umweltpolitik im internationalen Vergleich

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The examination consists of a scientific paper. The examination consists of a scientific paper (term paper/seminar paper) of 20-25 pages (60%), which is accompanied by an oral performance (40%). Within the framework of the term paper, a broader topic is dealt with that was treated in a course and is analyzed in the form of an in-depth elaboration, guided by a precise question. The oral performance can also take the form of group work, provided that the individual contributions are recognizable.

In the scientific paper, students show that they are able to discover important research questions, to work methodically, and to link theoretical approaches with empirical examples.

In the presentation, the students also show that they are able to present the connections between theory, methods, and empiricism.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The module introduces environmental politics from an international comparative perspective. The central institutions, actors, processes, content and outcomes of environmental politics will be considered and analysed comparatively and theoretically. A focus will be on policy conflicts and problems, governance instruments (implementation challenges) and actor constellations. The multiple levels of environmental policy making in the European and international context will also be considered. Finally, the module will consider which factors influence the environmental policies

of a country as well as the factors contributing to the successes and failures of pioneer and laggard states.

Intended Learning Outcomes:
After participating in the module, students will be able to identify key concepts and theories of environmental policy; to distinguish among different theoretical approaches to environmental politics research; to apply methods of comparative analysis to various environmental politics areas; to compare internationally the institutions, actor constellations, processes and outcomes of national environmental politics, and to evaluate environmental policy outcomes from a comparative perspective.

Teaching and Learning Methods:
The module is offered in the form of two seminars, each dealing with different, but complementary thematic areas of the module. The best approach to obtaining a deeper understanding of a module's topics through independent work and general discussion will determine the form of the seminar. Seminars offer the opportunity for both an instructor's direct input and a wide variety of active learning methods. During the seminars, deep discussions and students' inputs will help in understanding the material presented by the instructor. Concrete examples will be used to practice, analyse, and evaluate the material which has been presented. The presentations developed and given by the students and ensuing discussions of those presentations will also contribute to this understanding.

Media:
Course reserve readings, Online Reader, Whiteboard, PowerPoint

Reading List:
Katharina Holzinger, Thomas Sommerer, Was verursacht die Aufwärtsspirale in der Umweltpolitik? Der Einfluss internationaler Harmonisierung auf nationale Umweltstandards. Österreichische Zeitschrift für Politikwissenschaft 41(1), 53-72 2012. Martin Jänicke, Helmut Weidner (Hg.), Successful Environmental Policy. A Critical Evaluation of 24 Cases. Berlin 1995. Wolfgang Muno, Umweltpolitik, in: Hans-Joachim Lauth (Hg.): Vergleichende Regierungslehre. Eine Einführung. Wiesbaden, 349-372 2010. Miranda A. Schreurs, Environmental Politics in Japan, Germany, and the United States. Cambridge 2002. Paul Steinberg and Stacy VanDeveer eds., Comparative Environmental Politics: Theory, Practice, and Prospects (Cambridge: MIT Press 2012).

Responsible for Module:
Prof. Dr. Miranda Schreurs

Courses (Type of course, Weekly hours per semester), Instructor:
(POL23200) Umweltpolitik im internationalen Vergleich (Seminar 1) (Seminar, 2 SWS)
Ohlhorst D

(POL23200) Umweltpolitik im internationalen Vergleich (Seminar 2) (Seminar, 2 SWS)
Ohlhorst D

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

Module Description

POL60402: Technology and Development | Technology and Development

Version of module description: Gültig ab summerterm 2020

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

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

Description of Examination Method:
Students will submit 3 homework assignments/exercises throughout the semester. Assignments will include a short policy briefing (4-6 A4 pages, excl. reference list and title page), thoughtful contributions to at least three discussion topics in an online forum, and a group presentation (slides, video or poster). These homework assignments enable the students to demonstrate their mastery of the learning outcomes: the presentation addresses learning outcomes 1 and 2, the policy briefing learning outcomes 3 and 4, and the discussion comments learning outcome 5. The final grade reflects the sum of the homework grades.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none required (though Intro to IR would be helpful for students)

Content:
Technology is often promoted as a new "miracle solution" to longstanding developmental problems, among them, hunger, poverty, and gender discrimination. Yet a closer look shows this "miracle" is far from becoming a reality in many developing and emerging states. This seminar follows two goals: 1) to look behind the curtain to discover the challenges inherent in using technology for developmental purposes; and 2) to brainstorm about the opportunities - some as of yet unrealized - that technology creates and make concrete plans for realizing them.

Intended Learning Outcomes:
Upon completing this course, students will be able to:
1) identify and use theories of technology in explaining development activities;
2) evaluate the usefulness of these theories in real world development activities;

3) empirically identify trends in the use of technology in development;
4) contextualize (technological) development within broader global trends, including power shifts and responses to COVID-19; and
5) critically evaluate empirical evidence related to technological development programs.

Teaching and Learning Methods:
The seminar uses (online) discussions, guided projects, lectures and exercises to accomplish the above-listed goals. This combination of methods engages different types of student learners (e.g., visual vs. auditory) to gain basic knowledge, to articulate their own explanations of the challenges and opportunites of technological development, and to brainstorm about solutions to developmental problems facing today's policymakers.

Media:
PowerPoints, videos, newspapers/magazines, (online) whiteboard and/or discussion board, exercise sheets

Reading List:
Literature lists will be provided at the start of the semester. Readings include, but are not limited to:
1) Bernards, Nick. 2019. "'Fintech' and Financial Inclusion." In The Palgrave Handbook of Contemporary IPE, edited by Timothy M. Shaw, Laura C. Mahrenbach, Renu Modi and Yi-chong Xu. London: Palgrave Macmillan.
2) Arora, Payal. 2016. "The Bottom of the Data Pyramid: Big Data and the Global South." International Journal of Communication 10:1681-1699.
3) Hilbert, Martin. 2016. "Big Data for Development: A Review of Promises and Challenges." Development Policy Review 34 (1):135-174.
4) Kettl, Donald F. 2016. "Making Data Speak: Lessons for Using Numbers for Solving Public Policy Puzzles." Governance 29 (4):573-579.

Responsible for Module:
Pfeffer, Jürgen; Prof. Dr. rer. soc. oec.

Courses (Type of course, Weekly hours per semester), Instructor:
(POL60402) Technology and Development (Seminar, 4 SWS)
Mahrenbach L
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86085: Sustainable Transitions | Sustainable Transitions

Version of module description: Gültig ab winterterm 2025/26

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 module will be assessed in two inter-linked parts, reflecting the lecture + seminar setup. There will be a 60 min end of term written exam consisting of multiple choice questions, open questions and small tasks involving graphs (50%). In the exam students will be need to demonstrate that they grasp the key concepts presented in class and the empirical evidence discussed along state-of-the-art research papers. More specifically, students will need to showcase an understanding of socio-technical systems, the drivers and barriers to transition, the role of technology characteristics and innovation, the importance of finance and effects on developing countries. Alongside the course, students will work in groups (individual grading) on two assignments (50%). These assignments will involve working with data on real-world sustainabilty transition challenges in the OECD as well as non-OECD (i.e., developing) countries.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
This module focuses on climate change as one of the key dimensions of sustainability. Climate change is largely driven by the way we generate and use energy (incl. for mobility). A secondary driver of climate change is agriculture and land use change, which will also be discussed in class. Both the 2015 United Nations Paris Agreement on climate change and the UN Sustainable Development Goals call for a fast and extensive transition of our economies and societies. As the Intergovernment Panel on Climate Change (IPCC) puts it: "rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems [...]. These systems transitions are unprecedented in terms of scale, but not necessarily in terms

of speed [...]". This module introduces students to the challenges involved in this transition and the opportunities (e.g., in innovation, finance, and development) with a particular emphasis on the rate and direction of technical change. It compares the current situation with historical socio-technical transitions and derives the consequences for policymaking using concepts from the innovation and transitions literatures. It then focuses on the role of public policy in governing these transitions, considering the role of finance, institutions and policy feedback - again with a particular focus on emerging and developing countries. The module is designed for an interdisciplinary audience and we expect students to be open to learn from each other and be curious to understand different backgrounds, including the need to explain foundational concepts that may be new to some students but known to others.

Intended Learning Outcomes:
After successful completion of the module students will be able to:
* understand the importance of the rate and direction of innovation and technological change to address urgent challenges, such as climate change (SDG13)
* explain why large socio-technical systems typically only undergo slow transitions and how effective policies can accelerate the process
* recognize the opportunities and threats of sustainabilty transitions for developing countries
* realize the criticality of finance and investment for large transitions
* link their own actions and sphere of influence to sustainability challenges with a refined understanding of different impact channels

Teaching and Learning Methods:
The module will include a mix of teaching methods containing a lecture and a seminar. In the lecture students will be introduced to the frameworks, concepts and recent empirical evidence on the drivers of and barriers to sustainabiltiy transitions. They will learn about the policy, politics and historical background of sustainabilty transitions. In the accompanying seminar students will then be able to utilize their knowledge to critically discuss and evaluate related literature and current events. The seminar will be accompanied by real-world assignments involving data analysis and writing.

Media:
PowerPoint, Audio (e.g., podcast), Whiteboard, Case studies, Data

Reading List:
Howlett, M., Cashore, B. (2014). Conceptualizing Public Policy. In: Engeli, I., Allison, C.R. (eds) Comparative Policy Studies. Research Methods Series. Palgrave Macmillan, London.
Raworth, K. (2018). Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist. Random House Business.
Obama, B. (2017). The Irreversible Momentum of Clean Energy. Science 355(6321), 126-129.

These are background reads, the syllabus will cover state-of-the art research papers.

Responsible for Module:
Egli, Florian; Prof. Dr.sc. ETH Zürich

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86085) Sustainable Transitions - Lecture (Vorlesung, 2 SWS)
Lehofer C, Egli F, Toetzke M

(SOT86085) Sustainable Transitions - Seminar (Seminar, 2 SWS)
Lehofer C, Egli F, Toetzke M
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86111: Sustainability and Development: Causal Methods to evaluate Policy Impact | Sustainability and Development: Causal Methods to evaluate Policy Impact

Version of module description: Gültig ab winterterm 2025/26

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
The module examination is a research brief with a prefixed supplementary presentation.
The group presentation (10 minutes) of a research paper (individual grading) introduces students to the specific sustainability challenges developing countries face. The topics will be assigned during the kick-off meeting and the presentation accounts for 40% of the final grade. With the presentation the students demonstrate their understanding of the various empirical methods used in current research.
With this understanding, students will write an individual research brief (Approx. 3000 words) based on their own data analysis, accounting for 60% of the final grade. The deadline will be communicated in class, it is usually around two weeks after the block course. With the research brief, students show their ability to visualize data and critically reflect on the generalizability and policy conclusions that can be drawn from it. They also demonstrate that they are able to prepare evidence-based policy recommendations.

Repeat Examination:

(Recommended) Prerequisites:
Proficiency in English; motivation to engage in in-person debates and presentations; basic knowledge of statistics and econometrics (e.g., statistical significance levels, OLS). Experience with R is recommended (otherwise, students are expected to self-study R basics prior to the module).

Content:
Developing countries face both opportunities and challenges in sustainable transitions. For instance, transitions offer potential for carbon reduction, more resource equity, and economic diversification, but they may also induce short-term costs, be limited by technological capabilities, and require policy and behavior change. This course focuses on the methods and tools needed to evaluate the impact of policies aimed at fostering such change in developing countries, as well as the broader effects these transitions have on people, economies, and the environment.
Using real-world examples, we will explore three methods to evaluate causal impacts: willingness-to-pay (WTP), randomized controlled trials (RCTs) and difference-in-differences (DiD). Students will learn to apply these methods in an in-class “R data clinic” using datasets provided during the course. To illustrate, an example would be to assess whether training increases the share of small-scale farmers who apply sustainable fertilization in Indonesia. Group discussions, presentations, and hands-on activities will provide opportunities to critically examine the advantages and limitations of different approaches in various contexts.
By the end of the course, students will be able to apply the three causal methods in policy advisory work or further research, with a clear understanding of when and why specific methods are most appropriate.

Please only register if you can attend the kick-off session and all in-person sessions.

Intended Learning Outcomes:
After successful completion of the module students will be able to:
* recognize the opportunities and challenges of achieving sustainability in developing countries
* understand different methodological approaches for impact evaluation
* explain when and why specific methods are most appropriate
* apply data analysis tools to real world data sets

Teaching and Learning Methods:
The module consists of a block seminar.
The module includes a mix of teaching methods comprising lectures, group discussions, and practical sessions involving data analysis. Lectures will introduce students to recent empirical evidence focusing on energy and agriculture. Through these sectoral lenses, students will learn about the challenges, opportunities, and impacts of the green transition in developing countries. Students will critically discuss quantitative methods applied in recent academic research based on their presentations and hands-on coding sessions in R.

Media:
PowerPoint, Whiteboard, Case studies, Data

Reading List:

Gass, P., Gerasimchuk, I., Kuehl, J., Roth, J., & Wooders, P. (2021). Just transition to a green economy: Employment, economic, and social consequences of the transition to an ecologically sustainable economy in developing countries. Eschborn: GIZ, Deutsche Gesellschaft für Internationale Zusammenarbeit. https://www.iisd.org/publications/report/just-transition-green-economy

Gertler, P. J., Martinez, S., Premand, P., Rawlings, L. B., & Vermeersch, C. M. (2016). Impact evaluation in practice. Washington DC: World Bank Publications. https://hdl.handle.net/10986/25030

ILO (2012). Working towards sustainable development: opportunities for decent work and social inclusion in a green economy. Geneva: ILO. https://www.ilo.org/publications/working-towards-sustainable-development-opportunities-decent-work-and

OECD & Net Zero. (2024). Green industrial policies for the net-zero transition. OECD and Net Zero + Policy Papers No. 2.
https://www.oecd.org/en/publications/green-industrial-policies-for-the-net-zero-transition_ccc326d3-en.html

Responsible for Module:

Egli, Florian; Prof. Dr.sc. ETH Zürich

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

(SOT86111) Sustainability and Development: Causal Methods to evaluate Policy Impact (Seminar, 3 SWS)

Krämer C, Egli F, Fritz M, Luck N

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

Module Description

SOT86608: Advanced Methods for Measurement and Modeling of Choice Behavior (with Application to Mobility Policy) | Advanced Methods for Measurement and Modeling of Choice Behavior (with Application to Mobility Policy)

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The module examination consists of a project work with a corresponding final presentation. The project work is completed over the semester. It follows the project objective of investigating the impact of a mobility policy on individual travel-related behavior, e.g., the impact of an increase in parking charges on car use in cities.
The project work is developed in different phases. In the first phase, students develop an online survey. This survey contains a mobility policy experiment that the students must design themselves. This includes selecting a certain policy and its context and defining its policy attributes. In this phase, students demonstrate the ability to reduce the complexity of travel-related behavior decisions to a meaningful experimental setup using the relevant methodology.
In the second phase, students will distribute the survey, e.g., among class members, to collect data. This is followed by analyzing their collected data using econometric methods, in particular, discrete choice models. In this phase, students demonstrate their ability to select appropriate statistical methods and procedures as well as the ability to make model estimates meaningful for policy making.
At the end of the semester, the project's results are presented and explained in class. The duration of the presentation is 10 minutes. With this presentation, students demonstrate their communication competency in presenting scholarly work to a specialist audience.
In addition to the presentation, a detailed written report of ten to fifteen pages is submitted after the final presentation that summarizes project work according to academic standards. With the report, students demonstrate their ability to concisely and scientifically report their progress during the project. They further show their ability to adequately justify decisions, e.g., in the selection and design of the mobility policy for the survey, using scholarly reasoning. The students further demonstrate their ability to discuss the limitations of their project adequately, to make recommendations for future research, and ultimately to derive policy implications.

Overall, with this project work, students demonstrate their ability to independently investigate the impact of mobility policies on individual behavior from problem definition, implementation, and assessment.
The grading is based on the written report (90%) and the final presentation (10%). The partial grade for the written results from 40% for the work in the first phase, 40% for the work in the second phase, and 20% for scientific conduct.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of statistics, statistical programming, or machine learning is recommended, though not strictly required. A general interest in mobility poilcy would be beneficial for the design of the policy experiments.

Content:
This module focuses on using surveys, discrete choice experiments and econometric modeling to analyze mobility policies, e.g., congestion pricing, long-distance traveling policies, improved public transport systems, or introducing a new mode of transport. The module is organized in three parts: the first part introduces surveys and discrete choice experiments and teaches methods on how to conduct these in practice to obtain data. The second part focuses on building econometric choice models to analyze the collected data. The third part is about applications in mobility policy analysis. The module is structured in such a way that the methods taught in parts one and two can be understood and applied by students in other fields, e.g., health or international relations, too.

Intended Learning Outcomes:
This module introduces the students to the approaches of measuring and modeling the responses of (travel) behavior to (mobility) policies. The learning outcomes of this module allow also students from other fields to learn the methodological fundamentals and apply them to policy analyses in their field. The ultimate objective of this module is to enable students to understand and apply the tought approaches themselves. Upon successful completion of this module, students will be therefore able to ...
(1) ... outline and describe existing approaches in measurement and modeling [remembering, understanding],
(2) ... identify and conceptualize appropriate approaches given requirements from a (mobility) policy analysis question [remembering, creating],
(3) ... prepare, conduct, and analyze a survey and a discrete choice experiment [apply, creating],
(4) ... differentiate and discuss the strengths and weaknesses of approaches under different environments [analyzing],
(5) .. appraise policy insights, recommend policies from surveys and models, and identify limitations of chosen methods [evaluating],

(6)... present their work and results in a comprehensible, appropriate and scholarly manner as well as summarize this in a collected report.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. The lecture introduces the students to the field discrete choice experiments and econometric modeling to analyze mobility policies. During the semester will develop and conduct their own survey with discrete choice experiment with subsequent analysis using econometric modeling of the choices.

Media:
presentations, statistical programming in R

Reading List:
Hensher, David A., John M. Rose, and William H. Greene. Applied Choice Analysis. Applied Choice Analysis. Cambridge: Cambridge University Press, 2015. https://doi.org/10.1007/9781316136232.
Rose, John M., and Michiel C.J. Bliemer. “Stated Choice Experimental Design Theory: The Who, the What and the Why.” In Handbook of Choice Modelling, edited by Stephane Hess and Andrew Daly. Edward Elgar Publishing, 2014. https://doi.org/10.4337/9781781003152.00013.
Train, Kenneth E. Discrete Choice Methods with Simulation. Cambridge: Cambridge University Press, 2009.

Responsible for Module:
Loder, Allister; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86608) Understanding Human Decisions in Mobility and Beyond: Advanced Survey Design and Discrete Choice Modelling - Lecture (Vorlesung, 2 SWS)
Loder A (Beck F)

(SOT86608) Understanding Human Decisions in Mobility and Beyond: Advanced Survey Design and Discrete Choice Modelling - Exercise (Übung, 2 SWS)
Loder A, Beck F, Wessling V
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86611: Sustainability Politics and Policy | Sustainability Politics and Policy

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The exam (100%) will consist of a portfolio of tasks that will relate to the different parts of the course which is co-taught by faculty teaching in the concentration area. The aim of this portfolio is to document the student’s major activities and accomplishments throughout the course.

The portfolio will include a presentation (about 30 min, 50%) in the context of which they will interact with their peers. This will help them reflect on their academic goals and their progress as learners as regards the defined course objectives (see below).

Building on their presentations as well as on their reflections on the discussions in the lectures, they will later compile a report (about 10 pages, 50%) that will document what they have proceeded to learn. In the report, students will demonstrate that they have acquired the defined competencies (see below) and will reflect on their learning process.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
This module introduces students to theoretical debates about sustainable development and links the concept of sustainable development to different economic, social, environmental, and health policy areas. The lecture in this module examines the goals of "sustainable development" and the concepts of inter- and intra-generational justice. The module includes a historical overview of the sustainability concept looking into competing definitions and understandings. It investigates key theoretical and methodological approaches to examine such issues as rising government debt,

growing global competition for innovation, and intensifying global environmental degradation and resource scarcity. The lecture considers how policies differ in their "sustainability profiles" and the economic, social and political factors which are responsible for this variance.

Intended Learning Outcomes:
Upon completion of this module, students will be able to understand the roles and contributions different scientific and technological solutions as well as different social and behavioural approaches can play in designing, implementing and monitoring sustainable solutions. They will also be able to understand how different sustainability areas (e.g. economic, financial, educational, research, health, family, pension, mobility, environmental and energy policy) are being governed on the local, national and international levels. They will be able to highlight the interdisciplinary dimensions of sustainability, to analyse complex sustainability problems, and to develop concrete solutions.

Teaching and Learning Methods:
The course will be given as one lecture and will employ fitting methods to deepen the content such as exercises, group work or a laboratory.

Media:
Media like presentations, exercises, scripts and other media

Reading List:
Bornemann, Basil/ Knappe, Henrike/ Nanz, Patrizia (Ed.) 2022: The Routledge Handbook of Democracy and Sustainability. London: Routledge, 431-446. (https://www.lehmanns.de/shop/technik/52507134-9780367109585-the-routledge-handbook-of-democracy-and-sustainability)

Wurster, Stefan 2013: Comparing ecological sustainability in autocracies and democracies, in: Contemporary Politics, 2013, Vol. 19, No.1, 76-93. (http://www.tandfonline.com/doi/abs/10.1080/13569775.2013.773204)
A reader of texts with up-to-date and cutting edge scienitific literature will be made available at the start of the semester.

Responsible for Module:
Wurster, Stefan; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86611) Sustainability Politics and Policy (Vorlesung, 4 SWS)
Schreurs M (Mohammed N)
For further information in this module, please click campus.tum.de or here.

SOT60302: Media & the Public | Medien & Öffentlichkeit

SOT603021: 1 Credit Modules | 1 Credit Module

Module Description

CLA10718: Speech Training for University Life | Sprecherziehung für den Uni-Alltag

Version of module description: Gültig ab winterterm 2010/11

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter 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:
Die Studierenden fertigen am Anschluss an die Veranstaltungen einen schriftlichen Erfahrungsbericht (3-5 Seiten) an, in dem sie die Lernziele des Workshops dokumentieren (Prüfungsleistung).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
Die Stimme ist unser wichtigstes „Instrument" der Kommunikation. Die täglichen Anforderungen im Uni-Alltag könnten sein: langes und lautes Sprechen, die Notwendigkeit immer gut verstanden zu werden, eine Stimme, die einerseits durchdringend und tragfähig, andererseits interessant und angenehm für den Zuhörer sein soll. Und das soll alles nebenher funktionieren, ohne dass man sich darauf konzentrieren muss.
Aber wer kennt nach langem Reden z.B. bei Vorträgen nicht das kleine Kratzen im Hals, das Räuspern, die mangelnde stimmliche Belastbarkeit? Das Hantieren mit den eigenen Sprechwerkzeugen muss gelernt sein! Daher ist es ein absolutes Muss, diese präventiv zu pflegen und zu wissen, wie man mit der eigenen Stimme umzugehen hat.
Sie lernen worauf es beim deutlichen Sprechen ankommt und Sie üben klangvollen und lauten Stimmgebrauch. Darüber hinaus erfahren Sie, wie man durchs Sprechen seine Zuhörer

erreichen kann und welche Möglichkeiten es gibt, mit Lampenfieber umzugehen. Außerdem wird theoretisches Hintergrundwissen vermittelt, sowie Tipps zur stimmlichen Pflege gegeben. Die Inhalte werden in der Gruppe erarbeitet und an Texten erprobt.

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme am Workshop wissen die Studierenden worauf es beim deutlichen Sprechen ankommt und wie sie einen klangvollen und lauten Stimmgebrauch bekommen. Die Studierenden sind in der Lage, Ihre eigenen Stärken und Schwächen zu benennen sowie ihre persönlichen Lernerfolge hinsichtlich Sprechstimme, Artikulation, Atmung und Körperpräsenz zu bewerten.

Teaching and Learning Methods:
Die Workshopinhalte werden praktisch anhand von Körper-, Atem- und Stimmübungen erfahrbar gemacht. Außerdem wird theoretisches Hintergrundwissen durch Präsentationen vermittelt.

Media:
Präsentationen

Reading List:
Allhoff, D. W., & Allhoff, W. (2021). Rhetorik & Kommunikation: Ein Lehr-und Übungsbuch. Ernst Reinhardt Verlag.
Lang, A., & Saatweber, M. (2010). Stimme und Atmung. In :. Schulz-Kirchner Verlag.
Pawlowski, K., & Riebensahm, H. (2005). Konstruktiv Gespräche führen. Fähigkeiten aktivieren, Ziele.

Responsible for Module:
Slanitz, Alfred; Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Sprecherziehung für den Uni-Alltag (Workshop, 1 SWS)
Molin V
For further information in this module, please click campus.tum.de or here.

SOT603023: 3 Credits Modules | 3 Credits Module

Module Description

SOT10138: Project Weeks: Media World and Media Use | Projektwochen: Medienwelt und Mediennutzung

Version of module description: Gültig ab winterterm 2025/26

Module Level: Bachelor/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:
Die im Rahmen des Seminars angestrebten Kompetenzen zur Projektarbeit, zur Reflektion und zur Präsentation werden über folgende Prüfungsleistungen erfasst:
Projektarbeit mit verschiedenen Teilleistungen:
Exposé Zukunftsentwurf (250-300 Wörter, 20%),
Gruppenpräsentation (10-15 Minuten plus Diskussion, 20%),
Interaktive Darstellung oder Poster Zukunftsentwurf (40%),
Kurzpräsentation (5 - 10 Minuten, 20%)

Repeat Examination:

(Recommended) Prerequisites:
Deutschkenntnisse

Content:
Das Modul setzt sich mit der Bedeutung verschiedener Medien für unsere Gesellschaft, mit der Reflexion der eigenen Mediennutzung und mit möglichen zukünftigen Medienwelten auseinander. Wesentliche Aspekte hierbei sind:
- Einführung: Was sind Medien bzw. Massenmedien, welche Finanzierungsmodelle haben Medien, welche Herausforderungen stellen sich in unserer aktuellen Medienwelt, welche Vorstellungen existieren bereits über die Zukunft der Medienwelt?,
- Reflexion des eigenen Medienkonsums und Einordnung der Bedeutung verschiedener Medien,
- gesellschaftliche Funktionen von Medien kennen lernen,
- Entwickeln und Präsentieren eines eigenen Zukunftsentwurfs zur künftigen Medienwelt

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme am Modul sind die Studierenden in der Lage:
- die Bedeutung von Medien für unsere Gesellschaften und unsere eigene Wahrnehmung einzuordnen
- sich selbst und ihr Medienverhalten zu reflektieren ebenso wie gesellschaftliche Funktionen und Rahmenbedingungen von Medien
- Zukunftsentwürfe zu ihren Vorstellungen einer künftigen möglichen Medienwelt zu entwickeln und gegenüber professionellen Kommunikatoren zu präsentieren
- disziplinübergreifend in Projekten zu arbeiten, deren Fragestellungen über einzelne Disziplinen herausreichen

Teaching and Learning Methods:
Projektbasiertes Lernen, Reflektion, aktive Mitgestaltung seitens der Studierenden, Team-Arbeit: Arbeit in heterogenen, disziplinübergreifenden Teams, Zusammenarbeit in Zweier- und Dreier-Teams, Diskussionen in größeren Gruppen

Media:
Moodle-Kurs, Beamer, verschiedene Medien zur Bearbeitung des Projektseminar-Themas

Reading List:
https://mpfs.de/studie/jim-studie-2024/, https://mpfs.de/studie/sim-studie-2024/

Responsible for Module:
Voß, Miriam; Dr. phil. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Medienwelt und Mediennutzung reflektieren (Seminar, 2 SWS)
Voß M [L], Voß M
For further information in this module, please click campus.tum.de or here.

SOT603024: 4 Credits Modules | 4 Credits Module

Module Description

ED0312: Science and Technology Communication at the Deutsches Museum | Wissenschafts- und Technikkommunikation im Deutschen Museum

Version of module description: Gültig ab summerterm 2025

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 90	**Contact Hours:** 30

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

Description of Examination Method:
Die Modulprüfung erfolgt in Form einer Projektarbeit (z.B. eines Kurzvideos, Magazin- oder Radiobeitrags oder wissenschaftlichen Posters), in der die Studierenden ein aktuelles Technikthema auf Objekte im Deutschen Museum beziehen, damit ihr Verständnis von Problemen und Möglichkeiten der Wissenschafts- und Technikkommunikation dokumentieren und die Fähigkeit zur prägnanten und zielgruppengerechten Darstellung komplexer Technikthemen unter Beweis stellen.
Die Projektarbeit umfasst (1) ein Exposee in Form einer Kurzpräsentation (5-10 Minuten), (2) die konkrete Realisierung eines Mediums zur Wissenschaftskommunikation (z.B. Poster, Video, Radiobeitrag) und (3) eine Reflexion über Herausforderungen und aktuelle Bezüge der konkreten Realisierung in Form einer Kurzpräsentation (5-10 Minuten) plus Diskussion (Gewichtung: 1:1:1). In den unterschiedlichen Teilen der Projektarbeit zeigen die Studierenden jeweils im Bezug auf unterschiedliche Zielgruppen, inwieweit sie Herausforderungen und Möglichkeiten der Wissenschafts- und Technikkommunikation verstanden haben und anwenden können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Es gibt zahlreiche Möglichkeiten der Wissenschaftskommunikation. Welche spezifischen Möglichkeiten der Vermittlung gibt es in Technikmuseen? Wie kann man daran aktuelle

Technikdebatten anknüpfen? Wie lassen sich komplexe Sachverhalte in Form von Kurzvideos aufbereiten? Wie wird dabei die gesellschaftliche Relevanz wissenschaftlicher Themen dargestellt?

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, Herausforderungen und Möglichkeiten der Wissenschafts- und Technikkommunikation zu verstehen und Techniken für eine effektive und zielgruppenorientierte Kommunikation anzuwenden.

Teaching and Learning Methods:
Das Modul besteht aus Vortrag und Präsentationen der Dozenten zu Formen, Herausforderungen und Möglichkeiten der Wissenschaftskommunikation und Vermittlungsformen im Technikmuseum, Einzel- und Gruppenarbeit zu praktischen Beispielen im Deutschen Museum und einer kritischen Diskussion zum Medium Kurzvideo.

Media:
PowerPoint, Filmausschnitte, Übungsaufgaben

Reading List:
Marc-Denis Weitze, Wolfgang Heckl: Wissenschaftskommunikation - Schlüsselideen, Akteure, Fallbeispiele, Springer 2015.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Wissenschafts- und Technikkommunikation im Deutschen Museum (Seminar, 2 SWS)
Weitze M, Decker M
For further information in this module, please click campus.tum.de or here.

SOT603033: 3 Credits Modules | 3 Credits Module

Module Description

SOT53503: Applied Philosophy of AI: Public Dialog on Future Practices | Applied Philosophy of AI: Public Dialog on Future Practices

Version of module description: Gültig ab summerterm 2025

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

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

Description of Examination Method:
Students will engage with philosophical concepts through collaborative presentations and discussions, applying theoretical insights to real-world applications. The assessment consists of three components:

In-Class Presentations (40%)
Students will deliver a 25-minute group presentation analyzing philosophical texts and applying philosophical concepts to AI issues, and engage in the consequent discussion. Each student will be evaluated individually based on their contribution, analytical depth, didactic clarity, ability to answer questions, and engagement in the discussion.

Public Presentation (30%)
Building on feedback from the in-class presentation, students will adapt and refine their analysis for a second presentation and discussion in a new context involving non-academic audiences. These presentations will facilitate dialogue with professionals who incorporate AI into their work processes. Assessment will focus on how effectively students integrate feedback, contextualize philosophical concepts for different audiences, and engage with diverse perspectives.

Discussion Engagement (30%)
Students will actively participate in class discussions and prepare two structured responses (approximately 5–10 minutes each):
- Content-related questions that deepen understanding of presented material
- Constructive collegial feedback on peer presentations

This assessment structure evaluates students' ability to comprehend philosophical texts, apply theoretical frameworks to practical scenarios, communicate complex ideas clearly, and engage in meaningful intellectual exchange.

Repeat Examination:

(Recommended) Prerequisites:

Content:
- Concepts of the digital, data, text, information, models, digitization, and computation
- The relation of computation to interpretation, meaning, understanding, emotions, and lived experience
- Stochastic patterns in generative AI and their relationship to human language use
- Design and implementation of generative AI systems
- Types of meaning producible through computational processes
- Societal implications of AI influence
- Philosophical perspectives on the mind and AI
- Economic factors driving AI development
- Impact of AI on work
- Ethical challenges of AI development and deployment

Intended Learning Outcomes:
After completing the module, students will be able to:
- describe arguments from today's philosophical discussions on (generative) AI#
- describe insights from classical philosophical discussions of pertinent topics
- delineate features of meaning, interpretation, and understanding, and their relation to stochastic patterns
- understand ways in which (generative) AI can influence human thought, emotion, and behavior
- discuss implications of the use of AI for business and society
- present philosophical thought to a public audience

Teaching and Learning Methods:
The seminar employs a progressive pedagogical approach that prepares students to engage with AI professionals while developing critical philosophical perspectives. Through a combination of theoretical exploration and practical application, students will:
Methodological Framework
- Conceptual Analysis:#Examine core philosophical ideas and their implications for AI integration
- Hermeneutic Textual Engagement:#Interpret primary texts to extract relevant insights for contemporary AI challenges
- Collaborative Inquiry:#Participate in structured group work to develop multifaceted perspectives

Applied Learning Components

- In-Class Practice Presentations:#Deliver initial analysis in a supportive academic environment
- Comprehensive Feedback Process:#Receive structured critique from peers and instructors
- Professional Engagement:#Present refined arguments to AI industry professionals, facilitating authentic dialogue between philosophical theory and practical application

The seminar bridges academic philosophy with real-world technological developments through a scaffolded learning experience. Students first develop and refine their ideas within the classroom community before engaging with AI practitioners, allowing them to effectively communicate philosophical insights to audiences beyond academia while gaining valuable perspectives on how theoretical concerns manifest in professional contexts.

Media:
Online reader

Reading List:
Bisk, Yonatan, Ari Holtzman, Jesse Thomason, Jacob Andreas, Yoshua Bengio, Joyce Chai, Mirella Lapata, et al. 2020. “Experience Grounds Language.” arXiv. http://arxiv.org/abs/2004.10151.

Durt, Christoph, and Thomas Fuchs. 2024. “Large Language Models and the Patterns of Human Language Use.” In Phenomenologies of the Digital Age, by Marco Cavallaro and Nicolas De Warren, 1st ed., 106–21. New York: Routledge. https://doi.org/10.4324/9781003312284-7.

Manning, Christopher D. 2022. “Human Language Understanding & Reasoning.” Daedalus 151 (2): 127–38. https://doi.org/10.1162/daed_a_01905.

Stuart, Susan Aj. 2024. “Why Language Clouds Our Ascription of Understanding, Intention and Consciousness.” Phenomenology and the Cognitive Sciences, March. https://doi.org/10.1007/s11097-024-09970-1.

Responsible for Module:
Please open Export to see the person responsible for the module

Courses (Type of course, Weekly hours per semester), Instructor:
Philosophy of AI Meets Business AI (Seminar, 2 SWS)
Durt C
For further information in this module, please click campus.tum.de or here.

SOT603043: 3 Credits Modules | 3 Credit Module

Module Description

SOT53504: Responsible Quantum Computing | Responsible Quantum Computing [RQC]

Socio-technical Perspectives on Innovation and Responsibility in Quantum Computing

Version of module description: Gültig ab winterterm 2025/26

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

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

Description of Examination Method:
Students submit a concept of approximately 2000 words, in which they independently develop a workshop on responsible quantum computing for schools or adult education facilities. With this assignment, students demonstrate that they are able to apply theoretical knowledge to the practical design of outreach workshops, integrate different perspectives on responsible quantum computing, and link them to relevant theoretical frameworks. In doing so, they show their ability to critically assess the societal implications of responsible quantum computing and to translate academic insights into accessible learning formats.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
There are no specific prerequisites for participation in this module. Basic knowledge of technology, sociology, or innovation research is advantageous. A strong interest in interdisciplinary perspectives on technology and society is recommended, as the module combines various methodological and theoretical approaches.

Content:
The module focuses on analyzing regional innovation cultures and the associated socio-technical challenges. Students examine how responsibility is embedded in technological development and identify key influencing factors. Using selected case studies from science, politics, and industry, they explore different strategies for fostering responsible innovation. Additionally, methodological

approaches from STS research and ethnographic fieldwork are practically applied to contemporary developments in quantum computing.

Intended Learning Outcomes:
Upon successful completion of this module, students will be able to systematically analyze and compare regional innovation cultures in quantum computing. They will evaluate how innovation processes in this field are co-produced and critically assess their impact on societal and economic contexts. Additionally, students will acquire knowledge of planning outreach workshops and apply their theoretical knowledge in designing a workshop on responsible quantum computing for schools or adult education facilities. In doing so, they will be able to integrate different perspectives on responsible quantum computing and link them to theoretical frameworks.

Teaching and Learning Methods:
This module employs a combination of teaching and learning methods to create an interactive and practice-oriented learning environment. In addition to traditional lectures that introduce fundamental concepts, seminar discussions encourage students to actively engage with the content. Possible excursions to quantum computing laboratories provide direct insights into technological developments and their applications. Group projects enable students to independently analyze case studies in teams and critically reflect on them, while the use of ethnographic methods supports structured scientific investigations. Students actively participate in seminar discussions to engage with theoretical and practical aspects of the subject.

Media:
A variety of media formats support the learning process. Lecture scripts and scientific articles serve as the foundation for in-depth engagement with the module topics. Online discussion forums provide a platform for continuous student exchange and collaborative reflection on seminar content.

Reading List:
Coenen, C., & Grunwald, A. (2017). Responsible Research and Innovation (RRI) in Quantum Technology. Springer Science+Business Media, 19, 277–294. https://doi.org/10.1007/s10676-017-9432-6
Faullimmel, N. (2020). Responsible Research and Innovation in Quantum Technologies. Engineering and Physical Sciences Research Council (EPSRC).
Gibney, E. (2019). The Quantum Gold Rush. Nature, 574, 22–24.
Glickman, S. (2022). The History of Technoscientific Promises and the Promises of Technoscientific History. EASST Review, 41 (2). https://www.easst.net/article/the-history-oftechnoscientific-promises-and-the-promises-of-technoscientific-history/
Hilgartner, S. (2015). Capturing the Imaginary. Vanguards, Visions and the Synthetic Biology Revolution. In Science and Democrary (1. Aufl., S. 33–55). Routledge.
Hilgartner, S., Miller, C., & Hagendijk, R. (2015). Science and Democracy (1. Aufl.). Routledge. https://doi.org/10.4324/9780203564370
Inglesant, P., Hartswood, M., & Jirotka, M. (2016). Thinking Ahead to a World with Quantum Computers The Landscape of Responsible Research and Innovation in Quantum Computing.

Networked Quantum Information Technologies (NQIT); UK Quantum Technologies Programme; University of Oxford.
Jasanoff, S. (2004). The Idiom of Co-Production. In States of Knowledge. The Co-Production of Science and Social Order.
Roberson, T. (2023). Talking About Responsible Quantum: “Awareness Is the Absolute Minimum that … We Need to Do”. Nanoethics, 17(2). https://doi.org/10.1007/s11569-023-00437-2
Robertson, T., Leach, J., & Raman, S. (2021). Talking about Public Good for the Second Quantum Revolution: Analysing Quantum Technology Narratives in the Context of National Strategies. Quantum Science and Technology, 6, 1–8. https://hbr.org/2022/01/quantum-computing-for-business-leaders
Seskir, Z. C., Korkmaz, R., & Aydinoglu, A. U. (2022). The Landscape of the Quantum Start-Up Ecosystem. EPJ Quantum Technology. https://doi.org/10.1140/epjqt/s40507-022-00146-x
Smith III, F. L. (2020). Quantum Technology Hype and National Security. Security Dialogue, 51(5), 499–516.
Stilgoe, J., Owen, R., & Macnaghten, P. (2013). Developing a Framework for Responsible Innovation. Research Policy, 42, 1568–1580. http://dx.doi.org/10.1016/j.respol.2013.05.008
Ten Holter, C., Inglesant, P., & Jirotka, M. (2021). Reading the Road: Challenges and Opportunities on the Path to Responsible Innovation in Quantum Computing. Routledge, 1–13. https://doi.org/10.1080/09537325.2021.1988070
Ten Holter, C., Inglesant, P., Srivastava, R., & Jirotka, M. (2022). Bridging the Quantum Divides: A Chance to Repair Classic(al) Mistakes? Quantum Science and Technology, 7, 1–5. https://doi.org/10.1088/2058-9565/ac8db6

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Responsible Quantum Computing (Seminar, 2 SWS)
Stein J
For further information in this module, please click campus.tum.de or here.

Module Description

SOT63306: Project: Ethics of Responsibility in the Field of Interdisciplinary Research Activities | Projekt: Verantwortungsethik im Bereich interdisziplinärer Forschungsaktivitäten

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
Within the scope of a project work the examination will take the form of various interrelated exercise performances in which the students demonstrate their ability to analyze and evaluate social challenges and ethical conflicts inside of the case, to develop a problem-solving strategy, and to present their findings in a clear and concise manner: (1) presentation on problem identification (15 minutes / 25% of exam grade), (2) presentation on problem-solving strategies (15 minutes / 25% of exam grade) and (3) an individual reflection report on learning outcomes (800 – 1000 words / 50 % of exam grade) by analyzing and summarizing the process of the realization of knowledge in a structured and comprehensible manner.

Repeat Examination:

(Recommended) Prerequisites:

Content:
This module imparts knowledge in the following fields:
- complexity of interdisciplinary research projects with different coping strategies in an inter- and transdisciplinary perspective;
- insight into different normative conflicts, their ethical implications in the science of technologies, their special questions, problems, and strategies of ethical problem-solving;
- the analysis of case studies and specific current projects, and arising normative conflicts and social challenges caused by technology (e.g. environment, ecosystem, interrelationship between nature and culture, etc.);
- strategies for ethical problem-solving in specific fields of technology and sciences.

Intended Learning Outcomes:
Upon successful completion of this module, students are able to:
- identify different research perspectives of different disciplines, their abilities, opportunities and limitations.
- understand the complexity of research in the interrelationship of humans, nature and technology in an inter- and transdisciplinary perspective.
- identify specific normative conflicts in selected fields of techno- and / or natural sciences and society (e.g. scientific research and technological innovation vs. normative (e.g. ethical) acceptance in society in the field of different case studies).
- analyze normative conflicts and their potential ethical implications.
- evaluate these conflicts ethically and apply them to specific current projects
- develop a problem-solving strategy for a particular interdisciplinary project (e.g. different managing strategies, ethics commission within non-human and human centered)
- present their findings in a clear and concise manner

Teaching and Learning Methods:
We constructed this course series in order to support you to find your personal approach towards the big questions of our time. The recent developments in science and technology calls for an interdisciplinary discourse and the need for ethical guidelines within the ethical subdomains. In order to develop communication strategies, we use traditional definitions and methods from the different domains and find new ways of translation for the discourse. During each teaching session we invite you to choose among a bid variety of case studies in order to trigger your personal dilemma.
Research input of different disciplines (by lecturers) and studying key literature familiarize students with different perspectives of scientific disciplines, their opportunities and the possibilities of an interdisciplinary approach. Discussing case studies and other sources (e.g. historical or regional documents) trains students to identify the interdisciplinary challenges (knowledge), evaluate relevant issues and ethical conflicts caused by technological development, and to develop strategies of problem-solving and interdisciplinary research approaches. By being immersed in a concrete technology project and its implementation, students learn how to address research, normative and ethical conflicts, and to implement different concepts of decision-making and problem-solving. Presenting and discussing their work trains students to structure their arguments in a concise manner and defending their own findings and positions in academic debate.

Media:
Readings, presentation, discussion

Reading List:
Allhoff, Fritz, What Are Applied Ethics? http://files.allhoff.org/research/What_Are_Applied_Ethics.pdf
Archie, Lee; G. Archie, John, Introduction to Ethical Studies. An Open Source Reader, https://philosophy.lander.edu/ethics/ethicsbook.pdf
Deigh, John, An Introduction to Ethics, http://dx.doi.org/10.1017/CBO9780511750519.002

Felt, Ulrike: Responsible Research and Innovation, July 2017; file:///C:/Users/49173/Downloads/RRIGenomePreprint_2017.pdf.
Resnik, David B.: The Ethics of Science. An Introduction, // http://library.mibckerala.org/lms_frame/eBook/Resnik%20-%20The%20Ethics%20of%20Science%20(Routledge).pdf).
Singer, Peter: Ethics, in: Encyclopaedia Britannica, Chicago, 1985, pp. 627 – 648, (https://www.britannica.com/topic/ethics-philosophy, download 04.04.2022).
Van den Hoven, J. (et al.) (Eds.): Responsible Research and Innovation Actions in Science Education, Gender and Ethics. Cases and Experiences, New York (Springer) 2014.

Responsible for Module:
Slanitz, Alfred; Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Projektwoche: Verantwortungsethik im Bereich interdisziplinärer Forschungsaktivitäten (Seminar, 3 SWS)
Sandmann E
For further information in this module, please click campus.tum.de or here.

SOT603052: 2 Credits Modules | 2 Credits Module

Module Description

SOT62501: Stories and Histories. Experience Literature in Its Historical Context. | Geschichte und Geschichten. Literatur im historischen Kontext erleben

Version of module description: Gültig ab winterterm 2025/26

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** irregularly
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 22	**Contact Hours:** 38

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

Description of Examination Method:
Das Modul wird mit einem literarischen Text (800-1200 Wörter) abgeschlossen, in dem die Studierenden zeigen, dass sie philosophische, politische, soziale oder persönliche Fragestellungen im Kontext historischer Konstellationen in narrativer Form thematisieren können. Grundlage für die Erstellung des Textes ist eine fundierte Recherche, deren Vorgehensweise und Ergebnisse in einem Kurzreferat (13-17 Minuten) nachvollziehbar dargestellt werden.

Repeat Examination:

(Recommended) Prerequisites:

Content:
Der Workshop beschäftigt sich mit historischen Persönlichkeiten, Ereignissen oder Konstellationen auf Grundlage von historischen Quellen und literarischen Texten. Dadurch wird einerseits Geschichte in Geschichten lebendig, andererseits im kreativen Schreiben neue Reflexions- und Orientierungspotentiale erfahren. Der Blick auf historische Kontexte durch die persönliche Brille ermöglicht durch die individuelle Erfahrung des anderen eigene Positionen, Rollen und Wünsche zu hinterfragen.

Intended Learning Outcomes:
Die Studierenden sind in der Lage, unterschiedliche Materialien im Hinblick auf ihre Eignung als Quellen zu bewerten und im Hinblick auf exemplarische Fragestellungen zu interpretieren sowie

diese Quellen in einem literarischen Text (Kurzgeschichte, Brief, Song etc.) zur Vermittlung einer philosophischen, politischen, sozialen oder persönlichen Fragestellung adäquat einzusetzen. Darüber hinaus sind die Teilnehmenden in der Lage, durch sachbezogene Fragen und konstruktives Feedback Recherche- und Gestaltungsprozesse zu unterstützen.

Teaching and Learning Methods:
Im Workshop wird sowohl historische Quellenarbeit praktiziert als auch die Reflexion mittels literarischer Schreibprojekte geübt. Ein Rechercheprojekt, dessen Vorgehensweise und Ergebnisse in einer Kurzpräsentation vorgestellt werden, bildet die Grundlage für einen kurzen literarischen Text, der im Kurs besprochen wird.
Geführter Rundgang in Ausstellungen und Archiven, Lektüre von literarischen Texten, Recherche und Interpretation von Quellenmaterial, Übungen zum kreativen Schreiben, Feedbackgespräche.

Media:
Vortrag, Reader, Ausstellungen, historische Quellen inkl. Film- und Fotomaterial

Reading List:
Leonie Schöler: Beklaute Frauen. Denkerinnen, Forscherinnen, Pionierinnen: Die unsichtbaren Heldinnen der Geschichte, München 2024.
Stefan Zweig: Sternstunden der Menschheit. Vierzehn Miniaturen, Fischer TB oder Reclam UB u.v.a. (erstmals Leipzig 1927).

Responsible for Module:
Slanitz, Alfred; Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Geschichte und Geschichten: Erika Mann – ein „kühnes Kind“ ihrer Zeit? (Workshop, 1,5 SWS)
Rehn H
For further information in this module, please click campus.tum.de or here.

SOT603053: 3 Credits Modules | 3 Credits Module

Module Description

SOT63502: Arts & Technology. A Practice-oriented Introduction to Applied Cultural Studies | Arts & Technology. Eine praxisnahe Einführung in angewandte Kulturwissenschaften

Version of module description: Gültig ab winterterm 2025/26

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

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

Description of Examination Method:
Das Modul schließt mit einer Prüfungsleistung in Form (1) eines Kurzreferats zu einem Kunstwerk (10-15 Minuten plus Fragen) sowie (2) in der mündlichen oder schriftlichen Präsentation (10-15 Minuten oder 2 DIN A 4 Seiten inkl. Bildmaterial) eines Konzepts zur medialen Vermittlung eines Zusammenhangs im Kontext von Kunst und Technologie. In (1) zeigen die Studierenden, dass sie ein Kunstwerk verständlich beschreiben und in ausgewählten Aspekten nachvollziehbar interpretieren können. Mit (2) demonstrieren die Studierenden, dass sie in der Lage sind, in einer konkreten medialen Vermittlungssituation exemplarische Aspekte der Begegnung von Kunst und Technologie auszudrücken (z.B. Posterpräsentation zum Einsatz von VR-Technik in einem Theaterprojekt oder Entwurf eines Beitrags zu einer virtuellen Ausstellung). Details zu Vorgaben für die konkrete Ausgestaltung werden in der Lehrveranstaltung kommuniziert.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
Für Kunst und Technik verwendeten die alten Griechen ein und dasselbe Wort. Wo begegnen sich Kunst und Technik heute? Wie verstehen und verwenden Kunstschaffende neue Technologien? Als Erweiterung der Werkzeugtasche, als herausforderndes Thema oder als existentielle Bedrohung menschlicher Kreativität? Und welche Rolle spielen künstlerische Sicht- und Herangehensweisen für die Gestaltung neuer Technik? Mit diesen Fragen beschäftigt sich der

praxisorientierte Workshop sowohl in der Auseinandersetzung mit Kunstwerken als auch im Gespräch mit KünstlerInnen, KulturmanagerInnen und KulturwissenschaftlerInnen.
Die Lehrveranstaltungen führen in künstlerische Werke ein, erproben deren Interpretation im zeitgeschichtlichen und kunsthistorischen Kontext, fördern den Austausch in multidisziplinär zusammengesetzten Gruppen und ermutigen zur eigenständigen orientierenden Reflexion, z.B. über:
• Mensch und Natur: von Mutter Erde zum Metaversum
• Mensch und Maschine: von Prometheus zum Cyborg
• Entmystifizierende Maschinenästhetik vs. fetischistische High Tech Kultur

Intended Learning Outcomes:
Nach Absolvieren des Moduls sind die Studierenden in der Lage, ausgewählte Kunstwerke zu beschreiben und im Hinblick auf deren technologische Aspekte zu interpretieren. Darüber hinaus können sie Bezüge zu aktuellen Diskursen und/oder persönlichen Erfahrungen und Erwartungen herstellen und ein mediales Konzept zur exemplarischen Vermittlung dieser Bezüge entwerfen.

Teaching and Learning Methods:
Durch gezielten Input exemplarischer wissenschaftlicher Methoden und deren Anwendung an konkreten Kunstwerken üben die Studierenden Beobachtung, Beschreibung und Interpretation. Durch Lektüre, Ausstellungsbesuche und Gespräche mit KünstlerInnen und KuratorInnen wird sowohl Kontextwissen erworben als auch die Basis für die eigenständige Reflexion und Vermittlung von Kunst-Erlebnissen geschaffen. Dadurch werden die Studierenden in die Lage versetzt ihre disziplinären oder persönlichen Kompetenzen praxisorientiert einzubringen.

Media:
Präsentationen, Reader, Ausstellungen, Videos

Reading List:
R.L.Rutsky: High technē: art and technology from the machine aesthetic to the posthuman, Minneapolis 1999

Responsible for Module:
Slanitz, Alfred; Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Von Pixeln und Gärten – die digitale Kunst von Miguel Chevalier in der Kunsthalle München (Workshop, 2 SWS)
Gierling J
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86701: EuroTeQ Collider. Enhancing Connections for Sustainable Futures (MSc) | EuroTeQ Collider. Enhancing Connections for Sustainable Futures (MSc)

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
During this module, students must complete following tasks: producing a presentation that provides information on the project concept development and implementation, as well as a final report, charting the progress of their work/research over time. These assessments will evaluate a) the success of the project and b) the learning success of the students in oral and written form. Students will be graded based on the active participation in a group project (20%), a final presentation of project results (60%) and a final project report (20%). These examination requirements will assess the success of the project, but also examine the learning success of the students in oral and written form.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
This module is aimed at all students enrolled in a Bachelor or Master program at the TUM; it is thus designed as an interdisciplinary venue which brings together a range of scientific perspectives. No specific prior knowledge is required; however, its project-based character requires high levels of intrinsic motivation and the willingness to actively participate in a project.Please register for this course via TUM Online. If you have any questions or problems to register, please send an email to euroteq@ja.tum.de

Content:
"Enhancing Connections for Sustainable Futures" aims to promote an integrated approach based on three main areas: People, Nature, and Technology. In the "People" domain, the focus is on empowering and enabling communities. This involves connecting people's needs and aspirations through technology, including digital solutions, in various areas such as wellbeing,

health, culture, etc. In the "Nature" realm, the call concentrates on the conscious use of nature and the consideration of its resources. This includes examining interactions in ecosystems, safeguarding biodiversity and nature conservation, as well as utilizing renewable energies. Within the "Technology" sphere, the emphasis is on establishing efficient connections through technology, both digital and physical. This encompasses various fields such as information technology, logistics, transportation, manufacturing, communication, etc. Overall, the call aims to promote sustainable connections that enable meeting human needs, protecting the environment, and leveraging innovative technologies to achieve these goals.

The Technical University of Munich (TUM) joint forces within eight leading universities of science, technology and business to foster the European spirit in a EuroTeQ format to promote innovative engineering education across Europe. Together, we are created the first EuroTeQ Collider in 2022. Now, the journey goes into the second round. The Collider is an innovative learning format with the aim of bringing students together with vocational trainees and professionals to tackle challenges. The theme for the period 2024-2026 is “Enhancing connections for sustainable Futures”. The goal is to connect participants with different profiles and personalities to boost creativity, innovation, shared understanding, enabling participants to imagine new approaches and design disruptive solutions.

The module is a seminar that gives students the opportunity to apply their knowledge on topics related to the theme “Enhancing connections for sustainable Futures”. Within this overarching theme, we are offering challenges on three different topic-domains, namely:

• People – e.g., empowering and enabling communities, connecting people's needs and aspirations through technology (including digital solutions) in different areas such as wellbeing, health, culture, etc.
• Nature – e.g., on the conscious use of nature, taking into account environmental resources and the relationship of organisms to the environment: interactions in the ecosystem, safeguarding biodiversity and nature conservation, use of renewable energies, etc.
• Technology – e.g., efficient connections through technology, both digital and physical, in various areas such as information technology, logistics, transportation, manufacturing, communication, etc.

Within every topic domain, interdisciplinary (and international) teams of students, vocational trainees and professional learners are formed to develop solutions towards a desirable future, test and validate tools and create prototypes of their solutions. A selection of the best projects will be presented in a major high-level event, the EuroTeQaThon.

Intended Learning Outcomes:
After completion, all EuroTeQ Collider participants will be able to:
- Select and apply appropriate design, engineering and business approaches and tools to create an innovative and science-based solution to a real-life challenge.
- Develop a profound interpretation of a complex, real-life problem and its context using a system-thinking approach, considering multiple perspectives.

- Develop a problem-driven, creative, and integrative design, demonstrated by a concrete prototype that balances desirability, feasibility, and viability.
- Use disciplinary knowledge and expertise in an inter-disciplinary team to develop an innovative and scientifically sound solution in a European context.
- Communicate your ideas, at different levels of elaboration, via several mediums in an international context to a diverse set of stakeholders.
- Define and regularly reflect on personal and team development.

Teaching and Learning Methods:
A range of teaching & learning techniques will be applied:
- (pre-recorded) videos and online presentations, with podcasts and interviews, Q&A Sessions with experts
- This module is focusing on service-learning and project-based learning
- After a set of introductory sessions which provide input on the core topics but also project management, students will work on their projects in groups. Progress will be determined through project presentations during the semester, continuous feedback from the instructors, as well as peer-to-peer feedback.
- Presentational skills will be further facilitated through the requirement to present the results
- As students and professionals will work together in a joint effort, all participants will not only improve their technical skills but also enhance their soft skills such as team spirit, flexibility to work in multicultural environments, and design thinking, which are also very important in professional life.

Media:

Reading List:

Responsible for Module:
Wester, Angela; M.A.

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

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

TUM Project Weeks (max. 6 ECTS) | TUM Project Weeks (max. 6 ECTS)

Module Description

CIT643002: 1.000+ Project week | 1.000+ Projektwoche
Team project week 1000+
Industrial internship (focus on SMEs)

Version of module description: Gültig ab winterterm 2025/26

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 50	**Contact Hours:** 40

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

Description of Examination Method:
In a 30 min poster presentation in the team in front of SME employees and with involvement of the examiner the students demonstrate their understanding and correct analysis of the SME`s operational processes and the given problem. The students show the development of at least one problem solving strategy and demonstrate their capability to argue for this approach in the discussion. In the discussion the students also reflect their own competences in the context of possible problems in a company.
The final grade is based on the poster presentation at the closing event.
Credits awarded only if students participate in the closing event

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none
Please register here: https://1000plus.cit.tum.de/

Content:
Many TUM Master's students complete their studies without a clear picture of company processes, corporate culture, or the concrete application possibilities of their skills. This is exactly where the 1.000+ format comes in.
As part of a one-week project, interdisciplinary student teams, whose professional composition is matched with the company's interests, are given the opportunity to get to know a real problem

of small and medium-sized enterprises (SMEs) and industry and to develop practical solution concepts together with the partner company.
In an introductory phase in the run-up to the project week, the company and the team get to know each other. During the project week, the teams immerse themselves in operational processes on site, conduct interviews, observe internal procedures, and use role plays to gain a deep understanding of challenges in areas such as resource management, communication, product development, and decision-making.
The results of the project week are documented in the form of a poster and presented to the company partner in a final presentation at the end of the project week. A special highlight is the final change of perspective: the partner company presents its own view of the problem, which provides the students with valuable food for thought.
At the end of the week, all participating teams and partners come together at the mandatory 1.000+ closing event at TUM. There, all posters will be exhibited and the mutual exchange with the corporate partners will be deepened - an inspiring framework for learning from the experiences of other teams.

1.000+ is aimed at Master's students (from second semester) from all TUM Schools, doctoral candidates and young alumni. The project week offers a unique opportunity to combine theory and practice in a meaningful way - directly at the companies, realistically and beyond one's own discipline.

Offering period: twice a year
Registration via https://1000plus.cit.tum.de/
Registration for summer semester: july-nov in the previous semester/ for winter semester: april-june in the previous semester

Intended Learning Outcomes:
After successfully completing the module, participants will be able to understand operational processes and corporate culture.
They will be familiar with internal processes and will be able to apply innovation processes.
Students will be able to develop problem solving strategies for operational issues.
They will be able to work successfully in interdisciplinary student teams.

Teaching and Learning Methods:
o Introduction to business management and processes as part of an in-house internship
o Role play
o Solution development in an interdisciplinary team through interviews and understanding of internal processes

Media:
Whiteboard; Presentation: Poster, A0 portrait format (template will be provided)

Reading List:
Guidelines and preparation material provided by the company

Responsible for Module:
Hayden, Oliver; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
1.000+ Projektwoche (Praktikum, 2 SWS)
Hayden O
For further information in this module, please click campus.tum.de or here.

Module Description

ED120112: Projectweek: Diversity in urban design | Projektwoche: Diversität in der Stadtgestaltung

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** one-time
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 50	**Contact Hours:** 40

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

Description of Examination Method:
Die Modulprüfung erfolgt in Form einer Projektarbeit im Rahmen der Projektwochen und mit einer mündlichen Präsentation am Ende der Projektwoche. Der Umfang der Projektarbeit umfasst die Erstellung eines Objektes in Form einer 1:1 Installation im städtischen Raum. Anhand eines 1:1 Objektes weisen die Studierenden nach, dass sie zielgerichtet Lösungsansätze für Entwurfsaufgaben überschaubarer Größe und Komplexität erarbeiten können. Sie weisen nach, dass sie Konstruktionsprinzipien verstehen und anwenden, die eigene Arbeit nachvollziehbar darstellen und kommunizieren können. Sie zeigen, dass sie den Input geeigneter Fachleute im laufenden Entwurfsprozess verstehen und auf die eigene Arbeit anwenden können.

Repeat Examination:

(Recommended) Prerequisites:
Interesse an Gruppenarbeit, sehr gutes räumliches Vorstellungsvermögen. Grundlegende Erfahrungen und Kenntnisse des Entwerfens und Konstruierens aus dem Bachelorstudium werden vorausgesetzt.

Content:
Inhalt
Ziel der Projektwoche ist es das Thema Diversität auch im Stadtraum sichtbar wie erfahrbar zu machen und die historische Perspektive von Sammlung und Ausstellung um eine Einbettung in den zeitgenössischen Diskurs zu erweitern. Insbesondere Chancengleichheit in Lehre und Praxis der gestaltenden Disziplinen soll dabei im Fokus stehen.
Innerhalb der Projektwoche werden hierfür in einem 1:1 Design Build Workshop gemeinsam Installationen im Stadtraum Münchens konzipiert und umgesetzt. Ziel ist die Projekte und Architektinnen im Stadtraum zu vermitteln und einzuführen und das Projekt mit

zeitgenössischen Fragen in Architektur, und (Stadt-)Gestaltung zu verbinden. Durch das kollektive, fachübergreifende Selbstbauprojekt werden einerseits neue Wege der Lehre beschritten, andererseits tritt das Projekt aus dem universitären Kontext heraus und wird in der Öffentlichkeit präsent. Die Installationen bieten Möglichkeiten der Einbeziehung, der Interaktion und der Partizipation mit der Stadtgesellschaft.

Intended Learning Outcomes:
Nach der Teilnahme am Modul sind die Studierenden in der Lage,

- Darstellungsmethoden von sozial-komplexen Inhalten konkret und öffentlichkeitswirksam zugänglich zu präsentieren
- die architektonische Detaillierung in Bezug auf die Ausführung zu verstehen
- Das präzise und sparsame Einsetzen architektonischer Mittel zu erfassen
- Input geeigneter Expertinnen im laufenden Entwurfsprozess zu verstehen und auf die eigene Arbeit anzuwenden
- Kurzfristige und adäquate Lösungen von Problemen auf der Baustelle auszuführen
- Die Bedeutung von Teamarbeit bei einer 1:1 Umsetzung zu verstehen
- in Teams der eigenen Fachdisziplin, aber auch darüber hinaus in interdisziplinären Teams, die Sprache des jeweils anderen zu verstehen, eigene Entscheidungen zu rechtfertigen und mit Argumenten zu überzeugen

Teaching and Learning Methods:
Dies ist eine Intensiv-Woche in der mithilfe des kollektiven, fachübergreifenden Selbstbauprojekt einerseits neue Wege in der Lehre beschritten werden, andererseits tritt das Projekt aus dem universitären Kontext heraus und wird in der Öffentlichkeit präsent. Während der Projektwoche werden externe Spezialistinnen eingeladen, die sich mit dem Wirken von Frauen als Gestalterinnen und Entscheidungsträgerinnen im urbanen Raum auseinandersetzen. Diese geben Input durch Vorträge und erweitern die Methoden von Design Build. Mit dem kollektiven, fachübergreifenden Selbstbauprojekt lernen die Studierenden Darstellungsmethoden von sozial-komplexen Inhalten.

Media:
Workshop, Deskcrits, Schlusspräsentation

Reading List:
Eine umfangreiche Literaturliste wird den Studierenden zur Verfügung gestellt

Responsible for Module:
Hartmann, Jana; M.A.

Courses (Type of course, Weekly hours per semester), Instructor:
Projektwoche: Diversität in der Stadtgestaltung (Workshop, 2 SWS)
Jacob A, Kaestle A, Syren Z
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001410: ChangeMakers: Entrepreneurial and Design Competencies for Societal Transformation | ChangeMakers: Entrepreneurial and Design Competencies for Societal Transformation

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
This module's learning objectives are examined via exercises (“Übungsleistung”) comprising the three elements outlined below. There is no written exam.

(1) Group final presentation (50%): In the final session, you will present your team's approach and solution for a societally relevant challenge identified at the beginning of the course. The presentation format can be chosen by your team and should include the presentation of a design artifact. Design artifacts can include a 3-dimensional object, a visual representation, a video, a storyline, a systems map, and many other forms of storytelling and visualization. Presentations will last approximately 5 minutes, followed by a 5-10 minute Q&A and feedback round. Each team member must actively participate so your individual contribution is identifiable and appraisable. The final group presentation will showcase that you have acquired and can demonstrate essential entrepreneurial and design competencies: focus – you can identify whether a problem is worth solving; courage – you understand your role in creating change; imagination – you are capable of developing and articulating a vision; and action – you know how to take next steps.

(2) Individually written reflection paper (20%): At the end of the course, you will submit a short paper (2 pages excl. sources) reflecting on
(a) your overall experience with and synthesis of the course's format (considering both the experiential learning immersion and the reading package)
(b) your critical reflection on the design solution you and your team created
(c) whether and how the course allows and will allow you to generate hope in the face of critical societal challenges

(3) Daily course exercises (30%)

In each session during the project week, you will be asked to submit a small reflection exercise related to the day's content and learning objectives via Moodle. We will dedicate 10-15 minutes of each session to this exercise using a set of questions. You will be guided through the exercise by the course instructors. This will demonstrate that you have engaged with, understood, and critically reflected on the day's topic.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fluency in English; interest in entrepreneurship, design, and a sustainable future; willingness to work in a team;

Due to the nature of the assessments and the ongoing team-based work in this course, consistent participation is mandatory. If you need to miss a session for health reasons or other valid circumstances, please inform us in advance via email. We may provide an opportunity to make up the missed material or, in cases of documented illness, assign a "Q" grade (indicating a missed exam with an accepted medical certificate).

Please note: Conflicts such as overlapping courses or work commitments are considered planning issues and should be resolved before enrolling in the course.

Content:
In this module, students will acquire entrepreneurial and design competencies through experiential and scenario-based learning: Set in a future scenario, students will be confronted with signals (based on scientific projections) that make clear what circumstances we may live in in the future. The Impulse Symposium ahead of the project week will provide inspiration and insight to stimulate students' imagination of the future we might live in. During the immersive project week, participants will work in small teams to create a real-life practical solution for a larger societal problem: The first day of the project week creates space to explore what challenges students find relevant and care about, and to explore through design and entrepreneurial methods whether these challenges appear to be worth solving. Throughout the week, students will learn and apply creative problem-solving methods, entrepreneurial thinking and decision-making to work through that challenge they chose. Students will be encouraged to leverage Generative AI tools to illustrate the ideas they create. Students will be guided to apply visualization and prototyping methods as well as reflection techniques that will support them in producing a shareable vision of a livable and lovable future and identify why and how they can contribute to realizing it.
The module is intentionally structured to include an impulse before, as well as iteration and reflection after an immersive project week. In addition, students will receive a reading package. Combining these elements will allow students to start well-prepared, reactive their prior knowledge, inform themselves about relevant methods, and process and appraise new information.

Intended Learning Outcomes:
After successful completion of this module, students will be able to:

● Understand and apply basic entrepreneurial and design competencies, including: Focus for sophisticated problem identification; Courage to take an active role in creating change; Imagination to develop and articulate ideas; Action to take an idea forward towards implementation
● Leverage these competencies to retain hope in the face of critical societal challenges

While developing and articulating solutions in interdisciplinary project teams, students will learn how to plan, manage and conduct a project, mobilize scarce resources, act in the face of uncertainty, collaborate in a team, and present, discuss, and reflect upon their own solutions convincingly. In addition, working with future scenarios will strengthen students' creative confidence and analytical and strategic skills.

Teaching and Learning Methods:
This module relies on six core elements:

● Impulse – a university-wide public mini-symposium that includes high-quality inspirational speakers who will set the tone and give context.
● Project Week – an immersive one-week project-based experience including theory-driven and methodological impulses, team activities, interactive discussions, flipped classroom elements, and guided project work inside and outside the classroom.
● Iteration – a review of the work that has been created during the project week in small teams accompanied by feedback and support from peers and subsequent further development.
● Presentation – a celebratory moment where participating teams share their work with each other and discuss their process and results.
● Reflection – a moment to reflect on the experience and, importantly, plan for possible next steps of integrating the newly acquired skills into one’s work.
● Reading package - a collection of supporting course material, links, and articles to strengthen the understanding and sensemaking of the applied methods.

Media:
Presentations, videos, flipchart, whiteboard, digital tools, Zoom for feedback sessions, prototyping materials

Reading List:
Each semester students will be provided with a reading list relevant to the course.
Inspirational readings include (students will be asked to engage with a selection of inspirational readings):
*Arend, R. J. (2020). The roles of thought and affect on entrepreneurship – A new hope. Journal of Business Venturing Insights, 14. DOI: 10.1016/j.jbvi.2020.e00188.
* Brown, T., Carey, S.,& Wyatt, J.(2021). The next chapter in design for social innovation. Stanford Social Innovation Review.
* Giudice, M., & Ireland, C. (2023). Changemakers: How leaders can design change in an insanely complex world. Two Waves Books.

* Hari, J. (2023). Stolen focus: Why you can't pay attention--and how to think deeply again. Crown.
* Holiday, R. (2021). Courage is calling: Fortune favors the brave. Penguin.
* Hoppe, M., & Namdar, K. (2023). Towards entrepreneurship for a cause: educating transformative entrepreneurial selves for a better world. Entrepreneurship Education and Pedagogy, 6(4), 590-607.
*. Lans, T., Blok, V., & Wesselink, R. (2014). Learning apart and together: towards an integrated competence framework for sustainable entrepreneurship in higher education. Journal of Cleaner Production, 62, 37-47.
* Markovitz, D. (2020). How to avoid rushing to solutions when problem-solving. Harvard Business Review Digital Articles, 2–6.
* Mauch, C. (2019). Slow hope: Rethinking ecologies of crisis and fear. RCC Perspectives: Transformations in Environment and Society, 1. doi.org/10.5282/rcc/8556.
* Noel, L. A. (2023). Design social change: Take action, work toward equity, and challenge the status quo. Ten Speed Press.
* Thackara, J. (2005): In the Bubble: Designing in a complex world; The MIT Press.
* Wedell-Wedellsborg, T. (2017). Are you solving the right problems? Harvard Business Review, 95(1), 76–83.
* Weiss, L. (2017). Stop mindlessly going through your work day. Harvard Business Review Digital Articles, 2–4.

Responsible for Module:
Tryba, Anne; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
ChangeMakers: Entrepreneurial and Design Competencies for Societal Transformation (MGT001410, englisch) (Seminar, 4 SWS)
Tryba A, Diefenthaler A, Löhe T, Mayer C
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001443: Project Week 2024/25: Conflicts in Mining Critical Materials: Compromising in Sustainability Strategies | Project Week 2024/25: Conflicts in Mining Critical Materials: Compromising in Sustainability Strategies

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** one-time
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 60	**Contact Hours:** 60

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

Description of Examination Method:
To complete the course, students shall form groups representing different stakeholders and play their roles in the game set up in the class; then, make a presentation (50% of the grade) and write a group report (50% of the grade):
- showing their understanding of sustainability with respect to mining;
-their learning on costs, benefits, and challanges faced by a given stakeholder groups;
- conflicts and ways to find a compromise when it comes to mining strategies;
-importance of mining and its fair development.

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
The course will consist of three parts, which allows for a type of experiment in how exposure to mining practices influences decision making. The first set of sessions will serve to introduce the topic and record “unexperience” and “noncollaborative” perspectives and decision choices on the mining problems presented. Next, students will be exposed actual mining practices, examine the conflicts (standing or past) onsite in visits to open-pit mines in Germany or Austria, and shall form their own views and opinions on the real-world challenges associated with sustainability in mining. Finally, the students return to the stakeholder roles to review their sustainability goals and weights assigned to them, negotiation strategies and impact oriented behavior.

Intended Learning Outcomes:
The module targets students of all backgrounds interested in understanding decision-making processes, challenges associated with choices, and divergence in perspectives on the sustainability goals, in particular, in extraction of critical metals and minerals. The course will explain environmental and societal costs of mining, alongside economic benefits, in the context of the increased demand for metals and materials brought about by decarbonisation goals. Participants will learn about different approaches for addressing the intricate challenges faced by German and global mining industries striving to provide critical resources.

Teaching and Learning Methods:
Students will engage in role-playing exercises to learn the perspectives of three major stakeholder groups, (1) affected communities, (2) upstream producers, i.e. mining operators, and (3) downstream industrial consumers, e.g., automotive companies. They will use the interactive multiobjective optimization (iMO) tool, we prototyped, to test their decisions exploring interest alignments and stakeholder conflicts, fostering deeper understanding of the multifaceted issues surrounding the extraction and consumption of critical materials.

Media:

Reading List:
1. Yakovleva, N., & Nickless, E. (Eds.). (2022). Routledge Handbook of the Extractive Industries and Sustainable Development. Abingdon, UK: Routledge.
2. Hatcher, P., & Grégoire, E. R. (2022). Governance of extractive industries. In Handbook on Governance and Development (pp. 294-307). Edward Elgar Publishing.
3. Veiga, M. M., & Marshall, B. (2018). The extractive industries and society.
4. Veraart, F., Smits, J. P., & van der Vleuten, E. Extractive Industries and Society.

Responsible for Module:
Ikonnikova, Svetlana; Prof. Ph.D.

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

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

Module Description

MGT001446: Project week: Circular Economy Perspectives in Research and Practice | Project week: Circular Economy Perspectives in Research and Practice

Version of module description: Gültig ab winterterm 2025/26

Module Level: Bachelor/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 module examination consists of a final group presentation and a project report. The group presentation is 30 minutes long, with 20 minutes dedicated to presenting the project and 10 minutes allocated for a Q&A session and discussion. Additionally, students are required to submit a comprehensive project report, in which individual contributions are clearly highlighted. The grade for the presentation will make up 40% and the report 60% of the final grade.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
none

Content:
The module provides students with an interdisciplinary introduction to the concept and practical relevance of the circular economy. It emphasizes the complexity and diversity of circular strategies across engineering, natural sciences, economics, political science, and management.
Throughout the semester, students are introduced to foundational concepts of both circular economy and behavioral economics through lectures, guest talks, and interactive workshops. They learn how human behavior, decision-making, and incentive structures influence sustainable practices and how these insights can be applied to circular solutions.
Participants engage with real-world cases and are coached in interdisciplinary teamwork, stakeholder analysis, and strategic project development. The module prepares students to critically assess circular economy approaches and to develop their own solutions to current sustainability challenges.

A key component is the project week, during which students work in interdisciplinary teams on a challenge posed by an external practice partner. They apply their acquired knowledge and skills to analyze the problem, develop actionable solution strategies, and present their outcomes in both a written report and a final presentation.
The course fosters academic-practice collaboration, encourages creativity, and equips students with the tools to act as change agents for sustainability within academic, corporate, and policy settings.

Intended Learning Outcomes:
At the end of the module, students will have developed a deep and interdisciplinary understanding of the principles and applications of the circular economy, including ecological, economic, and social dimensions.
They will be able to critically reflect on the limitations of linear economic models and formulate strategies to support circular solutions in diverse contexts.
By working in interdisciplinary and international teams, students will strengthen their ability to collaborate across disciplinary boundaries and to integrate different perspectives when addressing complex sustainability challenges.
Through active participation in lectures, workshops, guest talks, and team coaching sessions, students will be equipped to apply theoretical knowledge from circular economy and behavioral economics to real-world problems.
They will gain practical experience in problem-solving and strategic thinking by working on real challenges provided by external partners, developing solution concepts that are realistic, actionable, and well-justified.
This includes identifying stakeholder needs, assessing feasibility, and communicating their ideas convincingly in written and oral form to academic and non-academic audiences.
Students will improve their skills in teamwork, project management, and innovation under real conditions, including the ability to work within tight timeframes and manage complex tasks collaboratively.
By the end of the course, students will be able to transfer their learning to future academic, entrepreneurial, or policy-making settings and contribute meaningfully to advancing circular economy practices in research and professional environments.

Teaching and Learning Methods:
The module combines a variety of interactive and student-centered teaching methods to promote interdisciplinary learning and practical application. Core content is delivered through a series of thematic blocks, each taught by experts from different TUM chairs.
Students engage with theoretical foundations of the circular economy and behavioral economics through lectures, guest talks, and flipped-classroom elements. Interactive workshops and structured peer exchanges encourage critical reflection and help students to apply abstract concepts to real-world contexts.
Throughout the semester, students work collaboratively in diverse teams, supported by coaching and input sessions on project management, communication, and presentation techniques. Regular feedback sessions help refine their approaches and ideas.

In the final project week, students tackle a real-world challenge posed by an external partner, working intensively in teams to develop practical solutions. They apply interdisciplinary methods such as stakeholder analysis, systems thinking, and strategic planning. The project week concludes with final presentations and a written report, which demonstrate both the outcome and the collaborative process of the student teams.

Media:

Reading List:
Behavioral Economics:

"Thinking, Fast and Slow" by Daniel Kahneman
A comprehensive overview of the dual-process theory of the mind, heuristics, and biases.

"Nudge: Improving Decisions About Health, Wealth, and Happiness" by Richard H. Thaler and Cass R. Sunstein
Explains the concept of "nudging" and how small interventions can significantly influence decision-making.

"Misbehaving: The Making of Behavioral Economics" by Richard H. Thaler
A memoir-style book that chronicles the development of behavioral economics.

"Predictably Irrational: The Hidden Forces That Shape Our Decisions" by Dan Ariely
Explores how and why people make irrational decisions and how to understand these patterns.

"The Undoing Project: A Friendship That Changed Our Minds" by Michael Lewis
A story of the collaboration between Daniel Kahneman and Amos Tversky, highlighting their contributions to behavioral economics.

Circular Economy:

"Cradle to Cradle: Remaking the Way We Make Things" by William McDonough and Michael Braungart
Introduces the concept of designing products and systems in a regenerative manner.

"Waste to Wealth: The Circular Economy Advantage" by Peter Lacy and Jakob Rutqvist
Discusses the business advantages of adopting circular economy principles.

"The Circular Economy: A Wealth of Flows" by Ken Webster
Provides an in-depth look at the circular economy, its principles, and implications.

"Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist" by Kate Raworth

Challenges traditional economic thinking and introduces a model balancing essential human needs and planetary boundaries.

"The Upcycle: Beyond Sustainability--Designing for Abundance" by William McDonough and Michael Braungart
A follow-up to "Cradle to Cradle," focusing on improving systems and products to create more positive impacts.

Responsible for Module:
Mohnen, Alwine; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Project week: Circular Economy Perspectives in Research and Practice (MGT001446, englisch) (Seminar, 4 SWS)
Burkhardt R, Heinrich V, Kessler A, Kober K
For further information in this module, please click campus.tum.de or here.

Master's Thesis | Master's Thesis

Module Description

CS0115: Master's Thesis | Master's Thesis

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 850	**Contact Hours:** 50

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

Description of Examination Method:
The module examination consists of the preparation and positive evaluation of the Master's Thesis (approximately 25 to 100 pages, depending on the topic). The overall grade is determined by the grade of the Master's Thesis.

Repeat Examination:
Next semester

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

Content:
Deepening the knowledge of current academic literature on a specific topic, which can be freely chosen from the program in consultation with the supervisor. Deepening the knowledge of appropriate research methods, as well as gaining experience in their application.

Intended Learning Outcomes:
After completing the module, students are able to derive complex scientific questions and to work on them independently using adequate scientific methods. In doing so, they demonstrate their ability to think analytically on their own. They are able to present their results conclusively, discuss them, and draw final conclusions.

Teaching and Learning Methods:
First, together with the supervisor, the topic is
the topic is narrowed down and a research question is developed. Within the framework of the Master's Thesis, the students work on this scientific question. Among other things, literature

research, theoretical models and/or empirical methods are applied. The actual teaching and learning methods depend on the respective research question and are decided jointly with the supervisor in each individual case.

Media:
Academic literature, software, etc.

Reading List:
in consultation with the supervisor

Responsible for Module:
Alle prüfungsberechtigten Dozenten/innen des Studienganges

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

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

Obligations | Auflagen

Module Description

SZ0304: German as a Foreign Language A2.2 | Deutsch als Fremdsprache A2.2

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 A2.1; Einstufungstest mit Ergebnis A2.2

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 wiederholen und ergänzen grundlegendes Vokabular /Ausdrucksmöglichkeiten zu Themen wie Ausbildung, Beruf, Wohnen, Freizeit und Mobilität. Sie lernen/üben ein erweitertes Spektrum an

Haupt- und Nebensätzen (z.B. indirekte Frage, temporaler Nebensatz) sowie den Konjunktiv II zu benutzen und sie wiederholen bzw. erweitern den Gebrauch der Präpositionen.
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 zu 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, die persönliche Wohnsituation, Gesundheitszustand, Freizeitverhalten und berufliche Situation im Präsens oder Perfekt beschreiben. Sie können Vorschläge machen und reagieren, Informationen austauschen und Ratschläge geben.
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 sind in der Lage 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:
Christina Thunstedt

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A2.2 (Seminar, 4 SWS)
Dechant S, Hanke C, Knippelmeyer-Margraf I, Kovacs O, Kummer-Rock A, Reulein C, Steidten R, Werkhausen R, Zendath I
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0321: German as a Foreign Language A1.1 plus A1.2 | Deutsch als Fremdsprache A1.1 plus A1.2

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	Language: German	Duration: one semester	Frequency: winter/summer semester
Credits:* 8	**Total Hours:** 270	**Self-study Hours:** 180	**Contact Hours:** 90

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, Einkaufen, Wohnen, Reisen und Gesundheit, einfache Gespräche in alltäglichen Situationen zu führen und in Hauptsätzen Alltägliches im Präsens und Perfekt zu berichten, unter Verwendung von Nomen,

Verben, Pronomen und Possessivartikeln, Modalverben, Imperativ und grundlegender lokaler und temporaler Präpositionen.
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 einfache Sätze zu verwenden, die auf die Befriedigung konkreter, in der Bewältigung des Alltags wesentlicher Bedürfnisse zielen:
Sie können einfache Fragen in alltäglichen Situationen stellen und beantworten, Tagesabläufe in Vergangenheit und Gegenwart beschreiben und einfache schriftliche Mitteilungen zur Person machen, Verabredungen treffen und in grundlegenden alltäglichen Situationen beispielsweise beim Einkauf oder im Restaurant ihre Wünsche erfolgreich kommunizieren, wenn die Gesprächspartner langsam und deutlich 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 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:
Christina Thunstedt

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A1.1 plus A1.2 (Seminar, 6 SWS)
Comparato G, Schlüter J, Steidten R
For further information in this module, please click campus.tum.de or here.

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:
Performance, testing the learning outcomes specified in the module description, is examined by a cumulative portfolio of competence and action-oriented tasks. Aids are permitted.
The examination performances are designed in their entirety to test the use of vocabulary and grammar, reading and/or listening comprehension, and free text production.
Oral communication skills will be tested via the use of appropriate idioms in written dialogue examples and/or in the form of an audio/video file. For this purpose, we observe the Basic Data Protection Regulation (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
This module teaches basic knowledge of German as a Foreign Language, taking into account intercultural and cultural aspects of the country, which will enable students to find their way around despite their limited knowledge of the language, e.g. when shopping, in restaurants, on public transport, etc.
They will learn/practice basic vocabulary on topics such as family, work, leisure and food, ask and answer simple personal/family questions, understand and use numbers, prices and times and report everyday activities in simple structured main sentences in the present tense, using verbs, nouns, personal pronouns, possessive articles and negation forms.
Students practice teamwork skills by collaborating on tasks in multinational groups.

Intended Learning Outcomes:
The module is oriented towards level A1 of the CEFR. After completing this module, students will be able to use everyday expressions and very simple sentences aimed at meeting specific needs of everyday life: They can introduce themselves and others and ask other people questions about themselves and give answers to questions of this kind. They can describe daily routines in basic structures and give basic information about themselves in writing. They can communicate their needs if interlocutors speak clearly and slowly and are supportive. Students learn how to organize their own learning process of the foreign language independently and effectively.

Teaching and Learning Methods:
The module consists of a seminar in which students study the learning content with targeted listening, reading, writing and speaking exercises. The communicative and action-oriented approach is implemented by combining these exercises in individual, partner and group exercises. Online material for controlled self-study of basic grammatical phenomena and communication patterns is provided to deepen and intensify the content taught during the course. Voluntary homework (for preparation and revision) consolidates what has been learned.

Media:
Textbook, multimedia-supported teaching and learning material, also online

Reading List:
Textbook: will be announced in the course

Responsible for Module:
Christina Thunstedt

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A1.1 (Seminar, 3 SWS)
Bakker S, Burmasova S, Comparato G, Grgic T, Huber D, Keza I, Koch H, Pinskaia I, Pletschacher T, Schippers M, Schlömer A, Schlüter J, Schmidt-Bender S, Selent D, Witzig B, Zerfass A

Deutsch als Fremdsprache A1.1 - EuroTeQ (Seminar, 3 SWS)
Lechle K
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0339: German as a Foreign Language B2.1 | Deutsch als Fremdsprache B2.1

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German	**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. 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 B1.2; Einstufungstest mit Ergebnis B2.1

Content:
Das Modul orientiert sich am Niveau B2 des GER. In diesem Modul werden Kenntnisse in Deutsch als Fremdsprache erarbeitet, die den Studierenden eine mündliche Diskurspartizipation zu aktuellen und wissenschaftlichen Themen ermöglicht. Die Studierenden behandeln Themen des Satzbaus und vertiefen ihre Kenntnisse zum Passiv sowie Strukturen, die für das Vergleichen relevant sind. Sie erweitern ihr Repertoire an Nomen, Verben und Präpositionen sowie an festen Verbindungen. Ein umfangreicher und differenzierter Wortschatz zu interkulturellen, sprachlichen und studienrelevanten Themen wird erarbeitet. Die Studierenden lernen den Gebrauch von

spezifischen Redemitteln für Meinungsäußerung, vergleichende Argumentation und persönliche Erfahrungsberichte.

Intended Learning Outcomes:
Im Anschluss an die Teilnahme an den Modulveranstaltungen können die Studierenden wesentliche Inhalte von authentischen Artikeln und Berichten aus dem eigenen Fach- und Interessensgebiet selbständig verstehen und wiedergeben. Sie sind in der Lage, in einer Diskussion oder Präsentation Standpunkte darzulegen, wobei sie komplexe Satzstrukturen und fachspezifisches Vokabular benutzen. Sie können begründen, warum sie einer bestimmten Meinung sind, und die Standpunkte anderer kommentieren.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese-, Schreib- und Sprechübungen in Einzel-, Partner- und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Durch kontrolliertes Selbstlernen sollen von den Studierenden eigenständig Grammatikthemen und Wortschatzübungen mit vorgegebenen (Online-) Materialien erarbeitet werden. Freiwillige Hausaufgaben (zur Vor- und Nachbereitung der Lehrveranstaltung) festigen das Gelernte.

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

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:
Christina Thunstedt

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache B2.1 (Seminar, 2 SWS)
Comparato G, Kraut-Schindlbeck S, Mielert A, Sabel B, Schlömer A, Sohlbach M, Thiessen E
For further information in this module, please click campus.tum.de or here.

Module Description

WZ8000: Accredited Requirement Proof of Proficiency in German | Anerkennung Nachweis Deutschkenntnisse

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

CS0052: Organic Chemistry | Organic Chemistry [OrgChem]

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
End of Semester

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

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

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

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

Media:
Blackboard, presentation (using script), exercises

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

Responsible for Module:
Prof. Nicolas Plumeré Dr. Alaa Alsheikh Oughli

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

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

Module Description

CS0066: Introduction to Process Engineering | Introduction to Process Engineering

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The exam performance is effected by a written test. Through comprehension questions it is reviewed whether the students have understood the basic priciples of process engineering. The students solve balance arithmetic problems and answer questions regarding the definitions and relations of material and energy balances. The students prove that they have understood the basics of conceptual process design by selecting suitable process units for a given separation task and by drawing of the process flowsheet. Non-programmable calculators and a handed-out formulary are allowed aids. Exam duration: 90 minutes.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Mathematics 1

Content:
Most important unit-operations: reactors, distillation, extraction, crystallization, absorption, membranes, filtration, evaporatoin. Material und energy balances of single units and whole processes. Conceptual process design.

Intended Learning Outcomes:
After sucessful completion of the module the students know the most important separation technologies of process engineering; the are able to balance them with respect to material and energy; they unterstand basics of reaction engineering; they can safely select unit operations and decribe their mode of operation.

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

Media:
Presentations, slide scripts, exercises

Reading List:
1. Basic Principles and Calculations in Chemical Engineering, 8th Edition, (David M. Himmelblau, James B. Riggs), Prentice-Hall Inc., New Jersey, 2012.
2. Introduction to Chemical Engineering: Tools for Today and Tomorrow, 5th Edition, (Kenneth A. Solen, John N. Harb), Wiley & Sons Inc., New Jersey, 2010.
3. Elementary Principles of Chemical Processes, 3rd Edition, (Richard M. Felder, Ronald W. Rousseau), Wiley & Sons Inc., New Jersey, 2004.
4. Perry's Chemical Engineers' Handbook, 9th Edition, (Don Green, Marylee Z. Southard), McGraw-Hill Education Ltd., New York, 2018.
5. Chemical Reaction Engineering, 3rd Edition, (Octave Levenspiel), Wiley India Pvt. Ltd., New Delhi, 2017.
6. Thermal Separation Technology: Principles, Methods, Process Design, 1st Edition, (Alfons Mersmann, Matthias Kind, Johann Stichlmair), Springer-Verlag Berlin Heidelberg GmbH, Berlin, 2011.

Responsible for Module:
Prof. Jakob Burger

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

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

Module Description

CS0257: Molecular Biology and Genetics | Molekularbiologie und Gentechnik [MolBio]

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 150	**Contact Hours:** 90

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

Description of Examination Method:
The performance of the exam consists of a written test (90 min) in which the students show that they are able to call up and structure their theoretical and practical knowledge and use it on problems. By creating written protocols of the executed laboratory experiments (for each experiment about 5 pages of protocol), the students prove that they can documentate and illustrate theoretical principles as well as the results and the corresponding analysis and assessment of the experiments (not graded course achievement).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successfully completed exam for the Cell- and Microbiology module (CS0256) or an equivalent module. As a prerequisite for participation in the practical course, the written examination for the lecture must be successfully passed.

Content:
molecular structure of DNA, plasmids, bacteriophages, mutagenesis strategies, bacterial genomes, prokarotic gene regulation, transformation of organisms, genetic engineering, genetic engineering regulation, genome editing, cloning of DNA fragments, heterologous gene expression, analysis methods for DNA, RNA and proteins

Intended Learning Outcomes:
After completion of the modul the students possess knowledge about the most important molecular biological methods. They know how to isolate, analyse and manipulate nucleic acids and possess knowledge about the transformation of microorganisms. They understand what a genetically engineered organism is and can assess the risks and benefits of genetic engineering experiments,

including the benefits of new transgenic strains for sustainable production processes. The students can perform and analyse molecular biological experiments and name possible sources of error.

Teaching and Learning Methods:
The theoretical basics of the experiments conducted in the practical course will be delivered in the lecture part via ppt-presentations, movies and white board. In the practical course, the students will self-reliantly perform, document and analyse their experiments.

Media:
PowerPoint, blackboard work, practical course script

Reading List:
Molekularbiologische Methoden 2.0, T. Reinard, Utb, 2. Auflage, ISBN: 978-3-8252-8742-9
Mikrobiologie, J. L. Slonczewski, J. W. Foster, Springer Spektrum, 2. Auflage, ISBN: 978-3-8274-2909-4
Genome und Gene, T. A. Brown, Spektrum, 3. Auflage, ISBN: 978-3-8274-1843-2
Gentechnische Methoden, M. Jansohn, S. Rothhämel, Springer Spektrum, 2. Auflage, ISBN: 978-3-8274-2429-7
An Intro to Genetic Engineering, Desmond S. T. Nicholl, 3ed., Cambridge University Press, ISBN: 978-0521615211

Responsible for Module:
Prof. Dr. Bastian Blombach

Courses (Type of course, Weekly hours per semester), Instructor:
Molekularbiologie und Gentechnik (Vorlesung) (Vorlesung, 2 SWS)
Blombach B [L], Blombach B

Molekularbiologie und Gentechnik (Praktikum) (Praktikum, 4 SWS)
Blombach B [L], Blombach B, Glawischnig E, Hädrich M, Vital S
For further information in this module, please click campus.tum.de or here.

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