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

Module Catalog

B.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 271

Module Description

CS0175: Advanced Mathematics 1 | Höhere Mathematik 1

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge in mathematics corresponding to basic knowledge of A-level students.

Content:
Selected topics from one-dimensional analysis and linear algebra that are required in engineering. In particular: real and complex numbers, mathematical induction, sequences and series, limits, functions, continuity, single variable calculus, systems of linear equations, matrices, determinants. The methods are presented during the lecture and are applied to specific examples related to sustainability in the exercise classes.

Intended Learning Outcomes:
After completion of the module, students understand the fundamental concepts and essential methods from one-dimensional analysis and linear algebra. They are able to apply mathematical arguments in these fields independently. Moreover, they can apply the central proof techniques and concepts and comprehend their mathematical background.

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

work in order to practice the adequate expression and independent application of mathematical arguments.

Media:
Blackboard, slides, exercise sheets

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

Responsible for Module:
Prof. Clemens Thielen

Courses (Type of course, Weekly hours per semester), Instructor:
Höhere Mathematik 1 (Übung) (Übung, 2 SWS)
Thielen C [L], Meier F, Thielen C, Wittmann A

Höhere Mathematik 1 (Vorlesung) (Vorlesung, 2 SWS)
Thielen C [L], Thielen C
For further information in this module, please click campus.tum.de or here.

Module Description

CS0028: Physics | Physics [Phys]

Version of module description: Gültig ab winterterm 2024/25

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

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

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

Repeat Examination:
End of Semester

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

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

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

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

Media:
Writing on the board, presentations, slide scripts

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

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

Responsible for Module:
Prof. Josef Kainz

Courses (Type of course, Weekly hours per semester), Instructor:
Physics (Exercise) (Übung, 2 SWS)
Kainz J [L], Gu A, Kainz J

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

Module Description

CS0220: General and Inorganic Chemistry | Allgemeine und Anorganische Chemie [Chem]

Version of module description: Gültig ab summerterm 2024

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

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

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

Repeat Examination:
Next semester

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

Content:
General principles of inorganic and physical chemistry: Atomic and molecular construction, structure of compounds, acid / base equilibria, redox reactions, thermodynamics, reaction kinetics and catalysis, fundaments on electrochemistry, selected reactions of inorganic chemistry

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

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

Media:
Blackboard, presentation (using script), exercises.

Reading List:
1) Theodore L., H. Eugene LeMay, Bruce E. Bursten, Chemie Studieren Kompakt, 10. aktualisierte Auflage, Pearson Verlag, München
2) Charles E. Mortimer, Ulrich Müller, Chemie, 10., überarbeite Auflage, Thieme Verlag, Stuttgart

Responsible for Module:
Prof. Herbert Riepl

Courses (Type of course, Weekly hours per semester), Instructor:
Allgemeine und anorganische Chemie (Übung) (Übung, 2 SWS)
Riepl H [L], Riepl H

Allgemeine und anorganische Chemie / Angleichung Chemie (Vorlesung) (Vorlesung, 2 SWS)
Riepl H [L], Riepl H
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.

Compulsory Modules Advanced Basics | Pflichtmodule Weiterführende Grundlagen

Module Description

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

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Exam achievement shall be done in the form of a 90 minutes written test (either written or e-test). Knowledge questions check the treated basic concepts of programming and algorithms. Small programming and modeling tasks test the ability to apply the learned programming language in order to solve simple problems.
Aids: A handwritten A4 cheat sheet (it is not allowed to write on the iPad and print! It must be handwritten); non-programmable calculator; We will also collect the A4 cheat sheet after the exam. Please write your name on it!

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

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

Basic algorithms and data structures:
- Recursion

- Search (e.g., binary search, balanced search trees)
- Sorting (e.g., Insertion-sort, selection-sort, quick-sort)

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

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

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

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

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

Responsible for Module:
Prof. Dr. Dominik Grimm

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

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

Module Description

CS0038: Advanced Mathematics 2 | Höhere Mathematik 2

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Advanced Mathematics 1

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

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

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

Media:
Blackboard, slides, exercise sheets

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

Responsible for Module:
Prof. Clemens Thielen

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

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

Module Description

CS0199: Statistics | Statistics

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Learning outcomes are verified in a written exam. The exam consists of assignments in which the students are to demonstrate that they understand the statistical methods conveyed as part of the module and are able to apply them to specific examples. Exam duration: 90 minutes
Aids: a non-programmable calculator + one A4 sheet (written on both sides) with any handwritten notes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Qualification for university entrance; good mathematical knowledge is an advantage.

Content:
Selected statistical methods required in natural sciences, engineering, or economics, especially from the fields of descriptive statistics (e.g., graphical representation of uni- and bivariate data, measures of location and spread, measures of association for bivariate data, descriptive linear regression), probability calculus, and statistical inference (e.g., confidence intervals, hypothesis tests). The methods are presented during the lecture and are applied to specific examples related to sustainability in the exercise classes.

Intended Learning Outcomes:
The students know the most important statistical methods required in natural sciences, engineering, or economics. They have understood these methods, are able to select and perform suitable statistical procedures for specific case studies, and can draw correct conclusions from the results. Furthermore, the students should be aware of the capabilities and limitations of the presented statistical methods and are able to perform simple statistical analyses using statistical software (e.g., R).

Teaching and Learning Methods:
Lecture using digital presentation and/or blackboard to convey contents and methods. In addition, concrete examples are discussed in the exercise classes through independent work or group work.

Media:
Slides, blackboard, exercise sheets, e-learning

Reading List:
Diez, Cetinkaya-Rundel, Barr: OpenIntro Statistics, 4th edition, https://www.openintro.org/book/os/ (2019).
Fahrmeir, Heumann, Künstler, Pigeot, Tutz: Statistik - Der Weg zur Datenanalyse, 8. Auflage, Springer Spektrum (2016).
Field, Miles, Field: Discovering Statistics Using R, SAGE Publications (2012)
Caputo, Fahrmeir, Künstler, Lang, Pigeot, Tutz: Arbeitsbuch Statistik, 5. Auflage, Springer Verlag (2009).

Responsible for Module:
Prof. Clemens Thielen

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

Statistics (Exercise) (Übung, 2 SWS)
Thielen C [L], Thielen C
For further information in this module, please click campus.tum.de or here.

Compulsory Modules Chemistry | Pflichtmodule Bereich Chemie

Module Description

CS0152: Physical Chemistry | Physikalische Chemie [PhysChem]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The learning results are going to be proved in form of a written test (120 min). The students solve physical/chemical arithmetic problems and answer questions for definitions or physical/chemical relations. They prove that they have understood the basic relations of physical chemistry that are highlighted within the scope of the module and can use the systems of equations. Calculators are allowed additives. Other additives can be permitted by the lecturer as needed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
A-level student knowledge of mathematics (especially differentiation and integration) and physics

Content:
Basics of chemical thermodynamics: laws of thermodynamics, forms of energy (U, H, G, S), relations of formulas; chemical equilibrium and chemical reactions; properties of gases; phase transition of pure substances and multiphase systems; two component systems; selected boundary surface phenomena; basics of reaction kinetics

Intended Learning Outcomes:
After successful completion of the module the students know the laws of thermodynamics; they are able to make calculations concerning U, H, S and G; they understand phase diagrams of one and two component systems, can create charts and calculate the condition of equilibrium of simple systems; they can calculate with partial molar quantities in multi component systems; they can use ideal and real gas equations; they are able to form and solve equations related to the kinetics of chemical reactions and to determine the order of reactions;

Teaching and Learning Methods:
Teaching methods: in the lecture the teaching content is communicated by a talk of the lecturer, supported by PowerPoint and sketches on the blackboard in which the latter form is chosen to derivate complex relations. To a limited extent this can be completed for selected topics by self-study of the textbook by the students. In relation to the teaching content exercise sheets are disbursed on which the students work in self-study before the tutorials. The solution and discussion takes place in the tutorials. Learning methods: at the postprocessing of the lecture especially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the physical-chemical relations and practise the usage of the systems of equations.

Media:
PowerPoint, whiteboard, exercise sheets, textbook, optional: script

Reading List:
Lehrbuch: P.W. Atkins, J. de Paula, Physikalische Chemie, 5. Auflage, Wiley-VCH, 2013

Responsible for Module:
Prof. Nicolas Plumeré Dr. Doris Schieder

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

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

Module Description

CS0155: Practical Course General and Inorganic Chemistry | Praktikum Allgemeine und Anorganische Chemie [Chem]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
In the lab, the protocol is graded for 15 experiments of increasing complexity to include principles from general to inorganic chemistry. The protocol (10 page) should include a detailed explanation of the experiments performed and the experimental methods used. The protocol should clarify that the students understood the principles behind the experiments they performed. They should discuss the experimental results, with a particular emphasis on discussing the discrepancy between the experimental results obtained and those expected. Pass/Fail Grading of the Practicum. The practicum is considered passed only if the protocol listed above meets the criteria of completeness, accuracy, and comprehensibility/vividness more than 50% each, with feedback given on a first draft.

Repeat Examination:
Next semester

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

Content:
General principles of inorganic and physical chemistry and experimental essays: Structure of compounds, acid / base equilibria, redox reactions, thermodynamics, reaction kinetics, selected reactions of inorganic chemistry.

Intended Learning Outcomes:
The students will know and understand chemical structures, aggregation states of compounds and the basic principles of chemical reactions. The students will get familiar with the practical work in chemical laboratories. They will be able to perform and formulate correctly chemical reactions,

and experimentally determine thermodynamic and kinetic aspects of chemical reactions. The successful participation in the module will enable the students to participate in the module of basic organic chemistry

Teaching and Learning Methods:
Laboratory experiments and equipment.

Media:
Laboratory equipment.

Reading List:
1) Practical Labor Script; 2) Theodore L., H. Eugene LeMay, Bruce E. Bursten, Chemie Studieren Kompakt, 10. aktualisierte Auflage, Pearson Verlag, München;

Responsible for Module:
Prof. Rubén Costa

Courses (Type of course, Weekly hours per semester), Instructor:
Labor-Praktikum Allgemeine und anorganische Chemie (Praktikum, 5 SWS)
Costa Riquelme R [L], Atoini Y, Besenböck J, Dubovec D, Englberger H, Hasler M, Helmbrecht A, Lim S, Lipinski S, Liss P, Scheerer J, Seoneray I, Wang W, Wenig T
For further information in this module, please click campus.tum.de or here.

Module Description

CS0215: Practical Course Organic Chemistry | Practical Course Organic Chemistry [OCP]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The assessment is done in the form of protocols of the laboratory experiments carried out (approx. 10 laboratory experiments per experiment 2-3 pages protocol) and the proof of the preparation by means of melting point determination. Content of the protocol is the correct experimental set-up, the experimental procedure, as well as a discussion of the experiment with procedure, error (sources), proof of the preparation by measured melting point (cf. with literature value). In this way, the students should prove that they are able to understand the theoretical basics of the experiment, to document their execution of the experiment and to prove the successful synthesis of a preparation. The submitted protocols are graded according to completeness, correctness and comprehensibility/clearness, whereby a one-time correction of the protocols is possible. The protocol is considered passed if the criteria are fulfilled by more than 50%. The module is considered passed if all protocols or preparations are passed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of organic chemistry, inorganic chemistry

Content:
Reflux boiling, crystallisation, distillation, sluicing, shaking out with immiscible organic solvents, thin layer chromatography, column chromatography

Intended Learning Outcomes:
The students have acquired practical skills for carrying out organic chemical reactions. On the basis of simple reactions, the typical handles of organic chemical work have been learned. After

completing the practical course, the students can correctly prepare and set up an experiment, carry it out, record it, analyse the result obtained and recognise possible causes of incorrect values.

Teaching and Learning Methods:
Through the students' own experiments under supervision, they practise handling chemicals and equipment, thereby acquiring manual skills and experimental dexterity. Approx. 10 experiments are carried out.

Media:
Practical laboratory

Reading List:
H.G. Becker, Organikum, 21. Aufl., Wiley VCH

Responsible for Module:
Prof. Nicolas Plumeré

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

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

Module Description

CS0168: Instrumental Analysis and Spectroscopy | Instrumentelle Analytik und Spektroskopie

Version of module description: Gültig ab summerterm 2024

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 135	**Contact Hours:** 105

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

Description of Examination Method:
The achievement of the intended learning objectives is assessed in a written final examination (90 minutes). The students demonstrate that they know and understand the basic concepts of the analysis methods covered. By means of concrete questions (sample tasks), the students show that they can also apply the acquired concepts in simple cases in a solution-oriented manner.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
In the module the basics of instrumental analysis are communicated. Instrumental analysis is also an essential building block in the development of chemical synthesis routes with increased sustainability. In the module, particular physicochemical characterization methods, basic principles of measurement and the setting of analysis instruments are disscussed in detail. In detail are these: optic/electricl/magnetic measuremnts, adsorption/desorption as basis for chromatopraphic techniques, adsorption/desorption related to vibrational spectroscopy and UV/Vis spectroscopy, nuclear resonance spectroscopy, mass determination and spectrometry, scatter methods, atomic spectroscopy and gas and high performance liquid chromatography. The handling of the received measuring results is explained by case studies.

Intended Learning Outcomes:
After visiting the required modul the students are able to select corresponding physicochemical analysis methods for underlying practical problems and to use these methods as needed. On the basis of the gained knowledge the students can analyse the obtained measuring results in a

competent way. They understand the importance of instrumental analysis for chemical syntheses in general and for sustainability in chemical synthesis in particular.

Teaching and Learning Methods:
The theoretical basics of the experiments conducted in the practical course will be delivered in the lecture part via ppt-presentations, movies and white board. In the practical course, the students will self-reliantly perform, document and analyse their experiments.

Media:
presentation, script, cases and solutions lab and equipment

Reading List:
script, sample solutions for the exercises

Responsible for Module:
Dr. Broder Rühmann

Courses (Type of course, Weekly hours per semester), Instructor:
Instrumentelle Analytik und Spektroskopie (Vorlesung) (Vorlesung, 3 SWS)
Rühmann B [L], Riepl H, Rühmann B, Urmann C, Zieleniewska A

Instrumentelle Analytik und Spektroskopie (Seminar) (Übung, 4 SWS)
Rühmann B [L], Riepl H, Rühmann B, Urmann C, Zieleniewska A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0166: Advanced Organic Chemistry | Organische Chemie für Fortgeschrittene [AOC]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The students are able to demonstrate thier understanding of chemical reactions concerned in this course in a written exam with formula equations (90 min). The students show their understanding of different classes of natural compounds in formula equations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
module organic chemistry

Content:
Fossil oil and natural gas as primary source, crack- und steam reforming reactions, technical olefin chemistry, technical aromatic chemistry, polyolefins, nitrogen containing organic intermediates, carboxylic acids and oxygen containing intermediates in polyester production. Chemistry of carbonyl compounds and carbohydrates.

Intended Learning Outcomes:
After successfully managing this module, the students are able to understand the chemical reactions of our fossil based chemical production. They can present product trees, based on side products or associated products. By this knowledge they can identify intermediates up to the ready polymer product. The students can apply typical reactions of different organic compounds.

Teaching and Learning Methods:
Lecture by academic teaching personnel with PP-presentations, books, printed matter and others. Visit of production plants of nearby chemical industry to see typical industrial scale of reactions. In relation to the teaching content exercise sheets are disbursed on which the students work

in self-study before the tutorials. The solution and discussion takes place in the tutorials. At the postprocessing of the lecture especially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a understanding of the chemical reactions of our fossil based chemical production and practise the presentation of product trees.

Media:
Powerpoint presentations, whiteboard, printed text of teaching

Reading List:
K. Weissermel, H.J.Arpe, Industrial Organic Chemistry, 4. Auflage, VCH Weinheim

Responsible for Module:
Prof. Herbert Riepl

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

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

Module Description

CS0172: Green Chemistry | Green Chemistry [GreenChem]

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
Students gain knowledge of industrial processes and the principles of Green Chemistry. After passing the exam, students are able to identify essential principles of Green Chemistry in examples of industrial processes. They are able to make simple suggestions on how existing processes could be changed so that they would comply with the principles of Green Chemistry. The written exam has a duration of 90 minutes. Aids are not permitted.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics of chemistry, physics and biology

Content:
The module contains an introduction to the basics of environment-friendly 'green' synthesis routes for chemical products. The 12 basic principles of 'green engineering' will be covered. Sustainably production and treatment, process optimizations and innovative technological approaches and optimized separation methods will be discussed. The different processes will be presented with respect to relevant environment aspects, sustainability and energy- as well as raw materials consumption.

Intended Learning Outcomes:
After completion of the module, the students are able to describe the basic principles of environment-friendly and sustainable production of chemicals and demonstrate them at the examples of selected process chains. They can determine and present specific resource requirements with respect to energy, raw- and auxiliary materials as well as the yields during production, emissions into air, water and soil, as well as amounts of wastewater and solid waste.

They are alse able to couple syntheses to preceding and subsequent processing steps. Thus, they can assess the sustainabilities of production processes autonomously.

Teaching and Learning Methods:
Lecture with blackboard and slide presentations for the development of technical concepts. Seminar with written tests. Self-study is essential to consolidate the course contents.

Media:
Lecture, blackboard, slides, group work

Reading List:
Jiménez-González, Constable, Green Chemistry and Engineering, Wiley-VCH, 2010

Responsible for Module:
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.

Compulsory Modules Molecular Biology | Pflichtmodule Bereich Molekulare Biologie

Module Description

CS0157: Cell Biology and Microbiology | Zell- und Mikrobiologie [MiBi]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The learning results are proved in a written test in which the students are to call up and remember important principles of biology without using additives. In addition the students prove that they are able to recognize and solve a problem in a certain time by answering the comprehension questions on covered basic cell and microbiology processes. Answering questions requires mainly the use of own formulations thereby the correct recall of important technical terms is additionally reviewed. During the examination the tasks are set in both languages and the processing of the examination tasks can take place either in German or English. Exam duration: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Basics of cell biology (cellular structure (cell wall, plasma membrane, endomembrane system, nucleus), differences between prokaryotic and eukaryotic organisms, theoretical basics of microscopy, transport processes, genetic flow of informations and basics of molecular genetics (e.g. DNA structure, transcription, translation, DNA duplication), basics of biological taxonomy using the example of selected production organisms (e.g. E.coli, S.cerevisiae, algae, fungi), usage of microorgamisms in industrial biotechnolgy (e.g. ethanol fermentation, ABE fermentation, protein synthesis)

Intended Learning Outcomes:
After having participated in the module units the students possess basic knowledge about the structure and function of biomolecules. They know important elements of pro- and eukaryotic cells and can differentiate between these life forms. They know the basics of the genetic flow of informations and of the most important metabolic pathways and can grade bacteria, fungi and plants to higher-ranking systematic groups. After completion of the module the participants know different microorganisms, can describe their properties and understand basic cellular processes. Furthermore, the students can reflect biological terms, define processes and are able to use their knowledge to solve problems. They understand basic ecological challeges and prerequisits of sustainable development.

Teaching and Learning Methods:
The teaching contents are imparted by a talk of the lecturer, supported by PowerPoint and blackboard sketches.

Media:
PowerPoint, blackboard work

Reading List:
"Brock Mikrobiologie" von Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl, Pearson, 15. Auflage (2020)
"Campbell Biologie"" von Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Pearson, 11. Auflage (2019)

Responsible for Module:
apl. Prof. Erich Glawischnig

Courses (Type of course, Weekly hours per semester), Instructor:
Zell- und Mikrobiologie (Vorlesung, 3 SWS)
Glawischnig E [L], Glawischnig E
For further information in this module, please click campus.tum.de or here.

Module Description

CS0216: Practical Course Microbiology | Praktikum Mikrobiologie

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The performance is effected by written protocols of the executed laboratory experiments (About 7 experiments and
for each experiment about 4 pages of protocol). With these protocols the students prove that they are able to understand the theoretical background of the experiments, to report their experimental procedure and to evaluate their results. Furthermore, they should show that they can discuss deviations of the expected results and possible reasons. Assessment of the course as passed/ failed. The course is only passed if the protocol listed above meets the criteria of completeness, correctness and comprehensibility/clarity each to more than 50%, whereby feedback is given on a first draft.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful completion of the module Cell and Microbiology (CS0256) or equivalent.

Content:
Microscopy, methods of colony isolation, colony count, differentiation of bacteria, isolation of microorganisms, identification methods for microorganisms, growth behaviour of microorganisms

Intended Learning Outcomes:
After module participation the students are familiar with the execution of experiments in microbiological labs and able to use the mediated microbiological working techniques at least in main features. They handle aseptic techniques and can identify microorganisms. In addition, they possess a deeper understanding of the theories which underlie the experiments, including the ecological significance of microbial metabolism. Furthermore, the students can report laboratory

experiments in a correct way and evaluate and analyse them by means of the theoretical backgrounds under guidance.

Teaching and Learning Methods:
Laboratory experiments in small groups (approx. 14 experiments) under guidance with previous introduction of the theory related to the particular experiments (lecture) as well as analysis of the results by experiment reports. Aspects related to safety issues in the laboratory are also covered in the lectures.

Media:
Practical course script

Reading List:
Practical course script

Responsible for Module:
Erich Glawischnig

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

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

Module Description

CS0210: Bioinformatics | Bioinformatik

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Learning outcomes shall be verified in a written test (90 minutes). Knowledge questions check the treated methods, algorithms and concepts in the field of bioinformatics and computational biology.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
CS0001 Foundations of Programming, CS0130 Grundlagen Biologie

Content:
Selected bioinformatic methods required for analyzing biological and bio-chemical data, especially from the area of biological databases (e.g. NCBI, Swissprot), algorithms for sequence alignments (e.g. Needleman-Wunsch, Smith-Waterman, ClustalW, BLAST) as well as methods for phylogenetic analysis. Methods shall be presented during the lecture. Within the scope of the exercise, their application shall be practiced based on specific case studies related to biotechnology and sustainability.

Intended Learning Outcomes:
The students know the most important bioinformatic methods and databases (e.g. NCBI, Swissprot, Needleman-Wunsch, Smith-Waterman, ClustalW, BLAST) for the analysis of biological and biochemical data. They will understand these methods and be able to select and perform appropriate bioinformatic procedures for specific case studies and real data, e.g. when working on biotechnology and sustainability projects.

Teaching and Learning Methods:
Lectures to provide the students with all necessary fundamentals of bioinformatics and its algorithms. In the exercises, the students will work on different analysis and programming tasks

and will develop basic Linux skills to conduct own analysis of biological and bio-chemical problems using bioinformatics tools and algorithms.

Media:
Slide presentation, blackboard, lecture and exercise recording, discussion forums in e-learning platforms, Exercise Sheets

Reading List:
Bioinformatik: Grundlagen, Algorithmen, Anwendungen, Rainer Merkl
Bioinformatics and Functional Genomics, Jonathan Pevsner

Responsible for Module:
Prof. Dr. Dominik Grimm

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

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

Module Description

CS0257: Molecular Biology and Genetics | Molekularbiologie und Gentechnik [MolBio]

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 150	**Contact Hours:** 90

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

Description of Examination Method:
The performance of the exam consists of a written test (90 min) in which the students show that they are able to call up and structure their theoretical and practical knowledge and use it on problems. By creating written protocols of the executed laboratory experiments (for each experiment about 5 pages of protocol), the students prove that they can documentate and illustrate theoretical principles as well as the results and the corresponding analysis and assessment of the experiments (not graded course achievement).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successfully completed exam for the Cell- and Microbiology module (CS0256) or an equivalent module. As a prerequisite for participation in the practical course, the written examination for the lecture must be successfully passed.

Content:
molecular structure of DNA, plasmids, bacteriophages, mutagenesis strategies, bacterial genomes, prokarotic gene regulation, transformation of organisms, genetic engineering, genetic engineering regulation, genome editing, cloning of DNA fragments, heterologous gene expression, analysis methods for DNA, RNA and proteins

Intended Learning Outcomes:
After completion of the modul the students possess knowledge about the most important molecular biological methods. They know how to isolate, analyse and manipulate nucleic acids and possess knowledge about the transformation of microorganisms. They understand what a genetically engineered organism is and can assess the risks and benefits of genetic engineering experiments,

including the benefits of new transgenic strains for sustainable production processes. The students can perform and analyse molecular biological experiments and name possible sources of error.

Teaching and Learning Methods:
The theoretical basics of the experiments conducted in the practical course will be delivered in the lecture part via ppt-presentations, movies and white board. In the practical course, the students will self-reliantly perform, document and analyse their experiments.

Media:
PowerPoint, blackboard work, practical course script

Reading List:
Molekularbiologische Methoden 2.0, T. Reinard, Utb, 2. Auflage, ISBN: 978-3-8252-8742-9
Mikrobiologie, J. L. Slonczewski, J. W. Foster, Springer Spektrum, 2. Auflage, ISBN: 978-3-8274-2909-4
Genome und Gene, T. A. Brown, Spektrum, 3. Auflage, ISBN: 978-3-8274-1843-2
Gentechnische Methoden, M. Jansohn, S. Rothhämel, Springer Spektrum, 2. Auflage, ISBN: 978-3-8274-2429-7
An Intro to Genetic Engineering, Desmond S. T. Nicholl, 3ed., Cambridge University Press, ISBN: 978-0521615211

Responsible for Module:
Prof. Dr. Bastian Blombach

Courses (Type of course, Weekly hours per semester), Instructor:
Molekularbiologie und Gentechnik (Vorlesung) (Vorlesung, 2 SWS)
Blombach B [L], Blombach B

Molekularbiologie und Gentechnik (Praktikum) (Praktikum, 4 SWS)
Blombach B [L], Blombach B, Glawischnig E, Hädrich M, Vital S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0186: Biochemistry | Biochemie [BC]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The learning results are proved in form of a written test (90 min exam duration). Based on questions to biochemical metabolic pathways and enzymology the students prove that they know the corresponding technical terms, designations and contents, that they have understand the basic relations and are able to apply their knowledge concerning the reactions taking place within the scope of kinetic and thermodynamic connections. For that purpose concrete computational tasks are assigned.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the modules "Organic Chemistry", "General and Inorganic Chemistry" and "Cell and Microbiology".

Content:
Enzymology: Within the module the students shall be introduced into basics of enzymatic catalysis. Nowadays, enzymatic catalysis and biochemical pathways represent a central building block in sustainable chemical synthesis, especially in the synthesis of biopharmaceuticals. In doing so theories relating to the course of enzymatic reactions, special aspects of kinetics and thermodynamics of enzyme-catalysed reactions, inhibition mechanisms as well as possibilities for calculating kinetic parameters shall be treated inter alia. Metabolism: Basic metabolic pathways such as glycolysis, citrate-cycle or gluconeogenesis shall be presented in the lecture. In doing so it is dealt with the general course of reaction cascades, thermodynamic aspects of energy generation as well as mechanisms of modulation of the individual paths.

Intended Learning Outcomes:
After sucessful completion of the module the students are able to describe and explain basic concepts, phenomenons and relations in the field of biochemistry. The students know important properties of proteins,understand the significance of kinetic parameters of enzymatic reactions and will be able to calculate them and apply to new issues (e.g. inhibition). Furthermore the students will be able to specify in detail basic metabolic pathways of the most important classes of substances, understand the particular steps and regulation systems of the respective paths. They have come to understand that biochemical reactions are usually reactions with very high sustainability, which can serve as models for sustainable chemical reactions.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations and blackboard sketches. Corresponding to the teaching content exercise sheets are prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentations, powerpoint, presentation script, exercise sheets

Reading List:
- Voet, D. , Voet, J.G., Biochemistry 4th Edition, Wiley-VCH, 2011;
- Nelson, D.L, Cox, M.M., Lehninger Principles of Biochemistry 5th Edition, WH Freeman, 2008;
- Berg, J.M, Tymoczko, J.L., Stryer, L., Biochemistry 6th Edition, 2006

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

Courses (Type of course, Weekly hours per semester), Instructor:
Biochemie (Vorlesung) (Vorlesung, 2 SWS)
Al-Shameri A [L], Al-Shameri A

Biochemie (Übung) (Übung, 2 SWS)
Al-Shameri A [L], Al-Shameri A, Kinateder T
For further information in this module, please click campus.tum.de or here.

Module Description

CS0218: Practical Course Biochemistry | Praktikum Biochemie [Pra BC]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Die Lernergebnisse werden in einer 30 minütigen mündlichen Prüfung überprüft, in der die Studierenden zeigen, dass sie die theoretischen Hintergründe der Versuche verstanden haben. Darüber hinaus sollen die wichtigsten Ergebnisse der laborpraktischen Versuche berichtet und diskutiert werden und es sollen Fragen zu den durchgeführten Experimenten beantwortet werden können.
Durch die korrekte Durchführung aller Laborexperimente mit korrekter Protokollierung (pro Experiment etwa 5 Seiten Protokoll) weisen die Studierenden zudem nach, dass sie die vermittelten experimentellen Arbeitstechniken anwenden und Laborexperimente ordnungsgemäß dokumentieren können (unbenotete Studienleistung).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Praktikum Mikrobiologie

Content:
Im Praktikum werden allgemein notwendige Grundlagen für das Arbeiten in biochemischen Laboren, sowie spezielle Methoden zur Trennung und Charakterisierung von Molekülen vermittelt. Darüber hinaus werden grundlegende biochemische Methoden vermittelt, insbesondere die Isolierung von Nukleinsäuren und Proteinen und ihre Analyse mittels Spektroskopie und Gelelektrophorese, sowie die Analyse enzymkatalysierter Reaktionen.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden mit dem Ausführen von Experimenten in biochemischen Laboren vertraut und in der Lage, die vermittelten experimentellen Methoden mindestens in den Grundzügen anzuwenden. Sie besitzen zudem ein tieferes

Verständnis der Theorien, die den Experimenten zugrunde liegen. Darüber hinaus können die Studierenden Laborexperimente korrekt protokollieren und anhand der theoretischen Hintergründe unter Anleitung auswerten und analysieren. Sie können ihre Ergebnisse kritisch hinterfragen und auf Plausibilität überprüfen. Die Studierenden verfügen somit über grundlegende praktische Fähigkeiten um in biologisch-chemischen Laboratotien an neuen, biobasierten Synthesen für eine nachhaltige Chemie zu arbeiten.

Teaching and Learning Methods:
Laborexperimente in Kleingruppen unter Anleitung mit vorheriger Einführung in die Theorie zu den einzelnen Experimenten, sowie Auswertung der Ergebnisse in Form von Versuchsprotokollen. In der Übung wird das Dokumentieren und Auswerten der Versuche anhand vorgegebener Daten und Fragestellungen erlernt. Die in der Übung erworbenen Fähigkeiten werden dann bei der Auswertung und Dokumentation der eigenen Experimente angewendet.

Media:
Praktikumsskript, ppt-Präsentationen, Tafelanschrift, Labor, Laborgeräte

Reading List:
Praktikumsskript

Responsible for Module:
Prof. Volker Sieber

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

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

Module Description

CS0187: Enzymes and Their Reactions | Enzyme und Ihre Reaktionen [EnzReact]

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
The learning results are proved in form of a written test (90 min exam duration). Based on questions to biochemical metabolic pathways and enzymology the students prove that they know the corresponding technical terms, designations and contents, that they have understand the basic relations and are able to apply their knowledge concerning the reactions taking place within the scope of kinetic and thermodynamic connections. For that purpose concrete computational tasks are assigned.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the modules "Organic Chemistry", "General and Inorganic Chemistry" and "Cell and Microbiology".

Content:
Enzymes are higly efficient catalysts of biochemical reactions in living organisms. Thus, they also can make high efficient and selective new catalysts for a future, sustainable green chemistry. With respect to this, the course offers a broad overview of enzyme classes (oxidoreductases, isomerases, hydrolases, lyases, transferases and ligases) and of enzyme-catalysed reactions. Thereby different reaction mechanisms are examined from a chemical point of view and hence the usage of enzymes in simple chemical implementations and technical fields is derived and comprehensively illustrated. The role of complex cofactors (radical forming, redox-active, electron switching, ion stabilisating and so on) is introduced and hence the limitations of enzyme reaction are worked out. With data bases of enzyme reactions and thermodynamic dimensions (e.g. from the theory of group contribution methods) target compounds of enzyme reactions especially in the field of renewables utilization are made accessible.

Intended Learning Outcomes:
After sucessful completion of the module the students know and understand enzyme-catalysed chemical reactions and their meaning for an enhanced sustainability in chemical synthesis. Based on this knowledge the students are able to design single- and multi-stage enzymatic processes and to evaluate them by means of thermodynamic and kinetic reaction data. Students will thus have the fundamental knowledge for more advanced courses, especially on the bioengineering of enzymes as catalysts for new, sustainable industrial chemical processes.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations, blackboard sketches and working on data bases. Corresponding to the teaching content exercise sheets are prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentations, PowerPonit, lecture script, exercise sheets, computer based work and enzyme reaction data bases

Reading List:
Voet, D. , Voet, J.G., Biochemistry 4th Edition, Wiley-VCH, 2011; Perry A. Frey und Adrian D. Hegeman, Enzymatic Reaction Mechanisms, Oxford Univ Press, 2006; Reinhard Renneberg, Darja Süßbier, Biotechnologie für Einsteiger, 3. Auflage, Spektrum Verlag Heidelberg 2010; A. Liese, K. Seelbach, C. Wandrey, Industrial Biotransformations, Wiley-VCH, 2006

Responsible for Module:
Prof. Volker Sieber

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

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

Compulsory Modules Process Engineering | Pflichtmodule Bereich Verfahrenstechnik

Module Description

CS0231: Reaction Engineering and Fluid Separations | Chemische und Thermische Verfahrenstechnik

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 180	**Contact Hours:** 120

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

Description of Examination Method:
The learning outcomes of the students will be tested in a written exam. There will be computational tasks on reaction engineering as well as thermal separation processes and reaction engineering. Students demonstrate that they can diagram and explain kinetics in engineering reactors. They demonstrate that they can answer questions about the fundamentals of catalysis. The design and balancing of process steps and the application of basic concepts and relationships in thermal separation technology will be examined. On the basis of various tasks (including computational tasks), the ability to solve the acquired knowledge to solve basic process engineering problems (design of stirrers, tubular reactors, etc.) within a limited time is tested.
Duration of examination: 120 minutes, auxiliary means: Four A4 pages of any written / printed paper and a non-programmable pocket calculator.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of Thermodynamics (CS0065), General Chemistry (CS0220)

Content:
Reaction kinetics, catalysts, features of homogeneous and heterogeneous catalysis; chemical reaction technology: homogeneous/heterogeneous reactions, reactor forms (e.g. stirrer tanks, tube reactor, packed bed, fluidized bed), indicators for reactor types (e.g. reaction vessels, flow tube), types of reaction control (e.g. fixed, not fixed, continuous, isothermal), flow conditions, and residence time behavior in reactors, heat balance of reactors, strategies for optimizing reaction

control. Introduction to fluid separation processes, design methods (calculation and graphical), single-stage and multi-stage operations, Mc-Cabe-Thiele-Construction, HTU-NTU-concept, fixed-point construction for extraction columns, feasibility limitations of unit operations. Applications in the field of distillation, absorption, extraction, membranes, adsorption.

Intended Learning Outcomes:
After having participated in the module the students are familiar with the most important reaction types and parameters of chemical catalysis and reaction technology and are able to apply suitable reaction controls for predefined chemical reactions, to perform kinetic calculations for common reaction types as well as to calculate parameters such as residence time behavior and heat demand of reactors. Thus, they are capable of also transferring methods learned from examples to new processes. After completion of the module, the students are able to design and assess the fluid separation processes distillation, extraction, absorption and membranes based on state diagrams. In addition, the students understand the basic principles of the said separation processes and the apparatus employed in an industrial context.

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

Media:
Supporting videos, script presentation sheets, exercise sheets

Reading List:
O. LEVENSPIEL: Chemical Reaction Engineering. 3. Auflage, John Wiley & Sons, New York (1998)
G. EMIG, E. KLEMM: Chemische Reaktionstechnik. 6. Auflage, Springer Vieweg, Berlin (2017)
SATTLER, K.: Thermische Trennverfahren: Grundlagen, Auslegung, Apparate, 3. Auflage, Wiley-VCH, Weinheim, 2002.

Responsible for Module:
Prof. Jakob Burger

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

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

Module Description

CS0188: [PVT]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The service is provided in the form of written protocols of the laboratory tests carried out (about 5 experiments and about 4 pages of protocol per experiment). In these, students should prove that they are able to understand the theoretical basis of the experiments, to document their experiments, and to evaluate their results. In addition, they should show that they can discuss deviations from the expected results and possible causes. Evaluation of the practical course as passed/failed. The practical course is only considered passed if the above-mentioned protocol meets the criteria of completeness, correctness and comprehensibility/clarity to more than 50% in each case, whereby feedback is given on a first draft.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Chemical and thermal process technology, Technical Thermodynamics, Chemical Thermodynamics and Mass Transport

Content:
Basic operations of process engineering, especially from the chemical, thermal and mechanic range e.g. destillation or particle distribution analysis.The content and the number of experiments are chosen from a of multiplicity of basic operations and rely on the available laboratory equipment.

Intended Learning Outcomes:
After graduation of the practical course, the students know basic processes and principles of process engineering (e.g. destillation, extraction, desiccation or particle distribution analysis and separation from a gas flow). They know how to design and calculate a chemical, physical or mechanic transformation. Furthermore, they know the process steps which are necessary for it.

Teaching and Learning Methods:
The acquisition of basic principles is prepared by handed out literature.
The student learns the theoretical understanding, the basic engineering of the experiment and the correct use of the installed measurement technique through the graduation of the practical course. The acquisition of these properties is proved at the day of the experiment and comfirmed by producing a report. Thereby also the ability is reviewed to evaluate and report data correctly.

Media:
Practical course script, laboratory equipment

Reading List:
Practical course script

Responsible for Module:
Burger, Jako; Prof. Dr.-Ing.: burger@tum.de

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

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

Module Description

CS0189: Bioprocess Engineering | Bioverfahrenstechnik [BPE]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The achievement of the desired learning goals is checked in a written final examination (90 minutes). The students show that they know and understand the basic concepts of biochemical engineering. With the help of concrete questions (e.g. calculations), the students show that they can also apply the concepts they have acquired in a solution-oriented manner in simple cases.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The lecture provides a fundamental overview of bioprocess engineering including all relevant process parameters, calculations and balances.This includes basic calculations of generation times, maximal specific growth rates as well as balancing of batch, fed-batch and continous fermentation processes. Furthermore, process relevant parameters such as oxygen transfer rates and heat transfer will be conveyed. Additionally, basic operation unit design as well as scale-up aspects will be examined. Examples of sustainable production processes are also given that use renewable raw materials, are climate-friendly and less harmful to the environment than conventional processes.

Intended Learning Outcomes:
The students acquire detailed and differentiated knowledge about concepts of various bioprocesses. Finally they are able to describe, calculate and design classical as well as complex bioprocesses. They will be able to evaluate the applicability of mathematical modelling of bioprocesses and will use this knowledge to analytically simplify highly complex process variants

Teaching and Learning Methods:
The lecture will be performed as ex-cathedra teaching to provide the students will all necessary fundamentals. Within the tutorial the students learn how to transfer this knowledge and get practically used with the content of the lecture. The tutorial will be used to internalise the theoretical knowledge based on case studies which allows the transformation on real-world as well as highly specific challenges of bioprocesses.

Media:
Slides, interactive quizzes, scripts, exercise sheets

Reading List:
Horst Chmiel, Bioprozesstechnik,
Spektrum Akademischer Verlag Heidelberg 2011

Responsible for Module:
Prof. Dr.-Ing. Michael Zavrel Nico Geisler

Courses (Type of course, Weekly hours per semester), Instructor:
Bioverfahrenstechnik (Übung) (Übung, 2 SWS)
Grundwürmer M, Zavrel M

Bioverfahrenstechnik (Vorlesung) (Vorlesung, 2 SWS)
Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0190: Practical Course Bioprocess Engineering | Praktikum Bioverfahrenstechnik [PCBPE]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
At the beginning of the practical course, there is an oral question to ensure that the students are sufficiently familiar or familiarized with the safety-related facts of the practicum script/ topic and the asscoiated equipment. The service is provided in the form of written logs of the laboratory tests carried out (about two experiments and at least ten pages protocol per test). In these, the students should prove that they are able to understand the theoretical basics of the experiments, to document the execution of the experiments and to evaluate their results. They should also show that they can discuss deviations from the expected results and possible causes. Assessment of the internship as passed/failed. The internship is only passed if the protocol listed above meets the criteria of completeness, correctness, and comprehensibility/clarity to more than 50%, whereby feedback is given on a first draft.

Repeat Examination:

(Recommended) Prerequisites:
Module Bioprocess Engineering

Content:
The practical course serves to deepen the content developed in the lecture Biochemical Engineering. In the internship, the theoretically conveyed basics are deepened by means of selected experiments. These practical experiments include the analysis of typical bioprocess parameters such as the determination of the specific growth rate. In addition, process-relevant offline parameters (e.g. the dry biomass) and online parameters (e.g. O2 and CO2 concentration in the exhaust gas) are recorded experimentally. Through the practical course, the students learn how to develop and optimize sustainable bioprocesses that are more climate-friendly than many conventional processes and help to reduce environmental pollution.

Intended Learning Outcomes:
After participating in the practical course, the students are able to work practically with bioreactors and scientifically evaluate fermentation processes. In addition, the students are able to transfer the calculations and practical experience they have learned to other complex processes and to use the resources of energy, water and raw materials efficiently.

Teaching and Learning Methods:
The practical course is based on carrying out cultivations in shake flasks and bioreactors. Bacteria and/or yeasts are used as the cultivation organism. Particular value is placed on the students' own initiative in order to promote a solution-oriented and independent way of working. The technical process characteristics are calculated and evaluated based on the recorded data.

Media:
slides, scripts, bioreactor

Reading List:
Horst Chmiel, Bioprozesstechnik,
Spektrum Akademischer Verlag Heidelberg 2011

Responsible for Module:
Prof. Dr.-Ing. Michael Zavrel Dennis Beerhalter Nico Geisler

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum Bioverfahrenstechnik (Praktikum, 5 SWS)
Zavrel M [L], Beerhalter D, Stadelmann T, Zavrel M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0217: Mechanical Process Engineering | Mechanische Verfahrenstechnik [MVT]

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The examination performance is provided in the form of a written examination. The students prove that they understand the structure and function of apparatuses and can carry out the basics of design, material selection and strength calculation. In the interaction of machines and apparatus, plant concepts are to be designed and/or specific aspects, such as the safety of operation, are to be discussed on the basis of P&Is.
Examination: written, duration: 90 minutes; auxiliary means: calculator

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Technical Mechanics (CS0036), Materials Science (CS0040), Fluid Mechanics (WZ1954)

Content:
The module teaches the basics necessary for the description of particle systems:
Particle size and shape, distribution functions, particle motion and interactions in heaps.
Furthermore, the basic operations applied to particles are presented: Crushing, mixing, separating, agglomerating, fixed and fluid beds, filtration.
For example, reference is made to applications in material and energy systems with regard to wood chipping, conveying, fermenter stirring and biomass combustion.

Intended Learning Outcomes:
After participating in the module, the students are able to apply the mathematical fundamentals of particle technology and to interpret the basic operations of particle process technology.

Teaching and Learning Methods:
The module consists of lecture and exercise.
The content of the module is conveyed during the lecture by speech and presentations. The students are encouraged to engage actively with the topics by integrating various self-search tasks and comprehension questions.
In the exercises, which take place in alternation with the lecture, serve for a stronger comprehension of the teaching contents. Hence, the students work on various calculation exercises and conduct different lab experiments in small groups.

Media:
Presentations, exercises

Reading List:
Bohnet, M., Hg.; 2014. Mechanische Verfahrenstechnik. Weinheim: Wiley-VCH-Verl. ISBN 9783527663569
Müller, W., 2014. Mechanische Verfahrenstechnik und ihre Gesetzmäßigkeiten. 2. Aufl. München: De Gruyter. Studium. ISBN 3110343568.
Rhodes, M.J., 2008. Introduction to particle technology. 2nd ed. Chichester, England: Wiley. ISBN 047072711X.
Schubert, H., 1990. Mechanische Verfahrenstechnik. Mit 36 Tabellen. 3., erw. und durchges. Aufl. Leipzig: Dt. Verl. für Grundstoffindustrie. Verfahrenstechnik. ISBN 9783342003816.
Schwister, K., Hg., 2010. Taschenbuch der Verfahrenstechnik. Mit 49 Tabellen. 4., aktualisierte Aufl. München: Fachbuchverl. Leipzig im Carl-Hanser-Verl. ISBN 3446424350.
Stiess, M., 1997. Mechanische Verfahrenstechnik 2. Berlin, Heidelberg: Springer Berlin Heidelberg. Springer-Lehrbuch. ISBN 978-3-662-08599-8.
Stiess, M., 2009. Mechanische Verfahrenstechnik. Partikeltechnologie. 3., vollständig neu bearbeitete Aufl. Berlin, Heidelberg: Springer Berlin Heidelberg. Springer-Lehrbuch. ISBN 978-3-540-32552-9.
Zogg, M., 1993. Einführung in die mechanische Verfahrenstechnik. Mit 29 Tabellen und 32 Berechnungsbeispielen. 3., überarb. Aufl. Stuttgart: Teubner. ISBN 9783519163190.

Responsible for Module:
Prof. Matthias Gaderer

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

CS0191: Downstream Processing | Downstream Processing [DSP]

Downstream Processing

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
The teaching content will be evaluated by a written examination for the learning outcomes of the module of a duration of 60 minutes. Based on questions to definitions and methods of downstream processes of biologically inspired processes the students prove that they know the corresponding technical terms, designations and contents, that they have understand the basic relations and are able to apply their knowledge. Using calculations, the students also show that they can calculate and design downstream processing methods.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module Bioprocess Engineering

Content:
The lecture gives a basic introduction to the downstream processing technologies of bioprocesses, in which all relevant separation methods are discussed. The content ranges from the determination of the respective process variables to the design and scaling up of the technologies. One focus is on avoiding, minimizing and recycling waste streams in order to develop sustainable bioprocesses that conserve resources and do not pollute the environment. In the parallel exercise, the lecture content is deepened in the form of exercises to be worked on.

Intended Learning Outcomes:
After participating in the module events, the students are able to define the terminology of the processing technologies of bioprocesses. These include above all the different separation methods, which contribute significantly to the feasibility of fermentation processes and other biologically based manufacturing processes. At the end of the module, the students are able to

develop, design and implement economical and sustainable bioprocesses based on the application and implementation of these processing methods.

Teaching and Learning Methods:
The lecture takes place mainly as frontal teaching in order to familiarize the students with all the necessary basics, which they need for the assessment of targeted and sustainable downstream processes in the field of biotechnology. In the exercise, design tasks are worked on in order to learn how to calculate and design DSP processes.

Media:
slides, interactive quizzes, short films, scripts, exercise tasks

Reading List:
Harrison, Roger G, and others, Bioseparations Science and Engineering, 2nd edn (New York, 2015; online edn, Oxford Academic, 12 Nov. 2020), https://doi.org/10.1093/oso/9780195391817.001.0001, accessed 8 July 2024.

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

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

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

Research Internship | Forschungspraktikum

Module Description

CS0053: Research Internship | Forschungspraktikum

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
Research-related works at the chairs and working groups of the TUMCS. The students shall each get tasks from the research field of the mentoring examiner. They shall work on these tasks under supervision in form of projects. Topics have to be allocated with regard to content and expertise to the study program. The students shall largely independently plan project works under supervision of the mentors. Project works shall be documented and evaluated in form of an internship report. Optionally a completing presentation of work progress may be done in form of oral presentations. Project works can also be done in cooperation with external institutions, e.g. companies.

Intended Learning Outcomes:
After having participated in the module the students especially understand principles of approach to (research) projects, planning of project works and critical evaluation of project results beside

subject-specific knowledge and working methods each imparted in the practical course in scientific working. The students will be able to apply these principles to new project tasks. Besides they are able to document, to interpret and summarise project works and results in a meaningful way in written form.

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

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

Reading List:
Technical literature related to mentioned topics

Responsible for Module:
Prof. Cordt Zollfrank

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

Forschungspraktikum Bachelor Biogene Werkstoffe (Praktikum, 10 SWS)
Costa Riquelme R [L], Atoini Y, Banda Vazquez J, Costa Riquelme R (Banda Vazquez J)

Forschungspraktikum Bachelor Pflicht (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

Forschungspraktikum Bachelor BVT (Forschungspraktikum, 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
For further information in this module, please click campus.tum.de or here.

Electives | Wahlmodule

Technical Elective Modules | Fachspezifische Wahlmodule

Module Description

CS0230: Applied Electrochemistry | Angewandte Elektrochemie [Appl. EC]

Version of module description: Gültig ab summerterm 2025

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

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

Description of Examination Method:
The achievement of the learning objective is checked by a oral examination (examination time: 30min). Up to 10% of the total number of points can be added to the grade of this oral examination as bonus points. The results of the online tests held during the semester determine the amount of bonus points. At least 65% of the points in the online test must be achieved in order to receive bonus points. It is not possible to raise the grade from 4.3 or worse to 4.0. This should encourage the students to continuously participate in the lectures and exercises that are very important for them. By means of questions on electrochemical aspects, the students prove that they know the relevant technical terms, designations and contents, have understood the basic interrelationships and can apply their knowledge of the processes taking place within the framework of electrocatalysis, local electrochemistry as well as spectroelectrochemistry. Concrete computational tasks are set for this purpose.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Allgemeine Chemie and Physikalische Chemie, Mathematik, Physik, Einführung in die Elektrochemie or other introductory lectures to electrochemistry.

Content:
- Electrochemistry of surface-bound species: The ideal case (Langmuir isotherm) and deviations (Frumkin isotherm). Heterogeneous electron transfer (Laviron formalism) to surface-bound species.
- Local electrochemistry: electrochemistry at microelectrodes, scanning electrochemical microscopy.
- Electrochemistry at the nanoscale: mass transfer & kinetics at heterogeneous electrodes. Applications of nanoparticle-modified electrodes. Single nanoparticle electrochemistry.
- Electrocatalysis: Molecular electrochemistry - theory and practice. Heterogeneous electrocatalysis - theory and practice. Methods in electrocatalysis research (DEMS, ICP-MS, FTIR, Raman, etc). Applications (electrochemistry and electrocatalysis of CO2, O2 and H2).
- Spectro-electrochemistry: coupling of EPR, UV-Vis, IR, Raman spectroscopy with electrochemistry. Electropolymerisation/conducting polymers. Correlation between optical properties, energy levels and redox potentials.

Intended Learning Outcomes:
The students learn the advanced knowledge of fundamental concepts of electrocatalysis, local electrochemistry and spectroelectrochemistry with reference to specific application examples. They are able to deal with the general principles of electrocatalysis and local electrochemistry and apply them to simplified problems of real electrochemical systems. A special focus is put on the understanding of the general and temporal interplay of electron transfer, chemical reactions and mass transport, in different electrocatalytic systems. Special focus will be on the theory of surface bound species, as well as molecular, heterogeneous and nanoparticle electrocatalysts. Furthermore, students will be familiar with electrochemical characterisation methods and will be able to apply their theoretical knowledge to these areas. Furthermore, students are familiar with industrially relevant processes, renewable energy conversion, green electrosynthesis and sustainable energy production and storage and can apply their theoretical knowledge to these areas. In addition, they know electrochemical characterisation methods and can apply them to real examples to design and optimise processes in research and industry.

Teaching and Learning Methods:
In this lecture, the course content is delivered through lectures by the lecturer using a fluent PDF script, PowerPoint slides and blackboard images. This allows for a detailed presentation of the course content and students are able to ask and discuss questions as they arise. PDF-script, PowerPoint slides and blackboard images provide visual support to help students understand the complexities of electrochemistry. In addition, students are provided with exercises to consolidate the content learned in the lecture. The solutions to these exercises are later presented and discussed by the students in an exercise lesson.

Media:
Presentations, PowerPoint, script.

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

Responsible for Module:
Prof. Nicolas Plumeré Dr. Ben Johnson Dawit Tedros Filmon

Courses (Type of course, Weekly hours per semester), Instructor:
Angewandte Elektrochemie (Übung) (Übung, 1 SWS)
Plumeré N [L], Moore Y

Angewandte Elektrochemie (Vorlesung) (Vorlesung, 2 SWS)
Plumeré N [L], Moore Y, Plumeré N
For further information in this module, please click campus.tum.de or here.

Module Description

CS0281: Biopolymers | Biopolymere [Biopol]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The learning results are going to be proved in form of a written test (90 min). The students answer questions about biopolymers and their physicochemical properties. They prove that they have gained knowledge about the discrimination, classification and extraction of biopolymers within the scope of the module and are able to apply this knowledge. No additives are allowed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic principles chemistry, physics and biology

Content:
The module deals with the structure and the function of polymers derived from nature (biopolymers). Covered are proteins, polysacharides, biogenic polyester, polyisoprenes and lignin. It is illustrated how bioploymers can be obtained from natural sources and which chemical reactions they are able to perform. Thereby the importance of the microstructure as well as the importance of the physicochemical properties in biological functions for the application-technical relevance of the biopolymers used as raw and functional material are covered.

Intended Learning Outcomes:
By attending the module the students are able to discriminate biopolymers and to classify them application-oriented. They know how and from which natural sources biopolymers can be obtained. The students acquire basic knowledge in the understanding of biopolymers and their physicochemical properties and can describe these properties and compare them among each other. Thereby they are able to differentiate suitable biopolymers application-oriented.

Teaching and Learning Methods:
Teaching methods: in the lecture the technical contents are communicated by a talk of the lecturer, supported by PowerPoint and skectches on the blackboard. In relation to the teaching content written tasks are disbursed on which the students work in self-study before the tutorials. The solution and discussion of the tasks as well as the visulaization of the teaching content by working with molecular models takes place in the tutorials. Learning methods: at the postprocessing of the lecture exspcecially while the exercises are solved the students keep themselves intensive busy with the teaching contents of the lecture and reach in this way a comprehensive knowlegde about biopolymers.

Media:
Lecture, blackboard sketch, foil script, molecular models

Reading List:
Türk, Oliver: Stoffliche Nutzung nachwachsender Rohstoffe
Grundlagen - Werkstoffe - Anwendungen, Springer Verlag

Responsible for Module:
Prof. Cordt Zollfrank

Courses (Type of course, Weekly hours per semester), Instructor:
Biopolymere (Seminar) (Seminar, 1 SWS)
Zollfrank C [L], Zollfrank C

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

Module Description

CS0180: Concepts of Physics and Chemistry in Nature | Concepts of Physics and Chemistry in Nature

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The performance test will be in the form of a written examination. The students should demonstrate in the exam the understanding of the physicochemical principles governing natural systems. They will be asked about
Basic concepts of physical chemistry applied to energy conversion in natural systems and to the structure of biomolecules. No auxiliary means are allowed in the exam. 120 min examination time

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
This course will intend to consolidate basic concepts in Physics, Mechanics, Chemistry, and Mathematics having the focus on Nature examples. As such, basic knowledge in Physics, Chemistry, Mechanics, and Mathematics is required.

Content:
The module aims at providing in-depth knowledge to the students in the field of Physics and Chemistry applied to Biology. The focus on basic physical and chemical laws, concepts, principles and processes, including chemical bonding, chemical kinetics, spectroscopy, thermodynamics, thermochemistry, mechanics, optics, among others. The students will be able to apply them to understand the functionality of biological compounds/materials towards a more practical vision of Nature and its possible technological application.
The course will be divided into several topics related to the chemical structure of proteins, sugars, and other bio compounds, the formation of micro and macro self-assembled structures, light manipulation, heat management, mechanics, and electrical control. Each topic will be addressed refreshing the most important physical and chemical concepts followed by their relevance in the structural and functional aspects of these materials and their possible application in technology.

Intended Learning Outcomes:
At the end of the module students will be able to analyse biological systems using a physicochemical perspective; describe the different ways energy is transformed and used by natural systems (thermally, optically, mechanical etc.). They will be able to analyse the structure of proteins and other biomolecules and to identify the forces that define their functionality. They will be able to apply these concepts to understand bio-based and bio-inspired technologies.

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

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

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Concepts of Physics and Chemistry in Nature (Exercise) (Übung, 2 SWS)
Costa Riquelme R [L], Atoini Y, Banda Vazquez J, Costa Riquelme R, Gutierrez Armayor D, Lipinski S

Concepts of Physics and Chemistry in Nature (Lecture) (Vorlesung, 2 SWS)
Costa Riquelme R [L], Banda Vazquez J, Costa Riquelme R, Zieleniewska A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0243: Practical Course Electrobiotechnology | Praktikum Elektrobiotechnologie [EBTP]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 75	**Contact Hours:** 105

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

Description of Examination Method:
The assessment is done in the form of protocols of the laboratory experiments carried out (7 laboratory experiments per experiment 2-3 pages protocol). In these, the students have to evaluate the data obtained in the practical experiment and compare it with the predictions of the underlying theoretical model. The evaluation and discussion of the results are recorded in the protocol together with the correct description of the experimental procedure. In this way, the students should prove that they are able to understand the theoretical basis of the experiment, document their experimental performance, evaluate and discuss the measurement data obtained. The submitted protocols are graded according to completeness, correctness and comprehensibility/clearness, whereby a one-time correction of the protocols is possible. The protocol is considered passed if the criteria are fulfilled by more than 50%, consequently 4.0 or better.
The module is considered passed if all protocols are passed. In this case, the grade for the module results from the averaged grades of the protocols, i.e. (sum grade protocol 1-7)/7.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful participation in the module " Introduction to Electrochemistry " as well as " Praktikum Allgemeine Chemie" and " Praktikum Biochemie ". In addition, knowledge of grammar school English.

Content:
During the block practical, several electrochemical experiments are carried out to characterise the active components. On the next day, the measurement results obtained are analysed together and compared with simulations of known models. On the basis of this, kinetic parameters are to

be determined (e.g., catalytic rate and Michaelis-Menten constant) as well as limits of the known models and sources of error are to be shown. The model systems used for this purpose are:
• Determination of the electrode surface by means of capacitive and potentiometric measurements.
• Voltammetry of freely diffusing redox mediators.
• Voltammetry of redox-active enzymes in solutions by mediated electron transfer.
• Measurement of glucose concentration by electrochemical methods.
• Voltammetry of redox-active enzymes immobilised on electrodes.
• Determination of the faradaic efficiency of biocatalytic NADP+ reduction using an FNR/V++ PVA-modified electrode.

Intended Learning Outcomes:
After successful participation in this module, the students are able to:
• handle electrochemical apparatus safely (potentiostats, electrochemical cells).
• carry out electrochemical measurements of biocatalytic systems (prepare the electrodes, set up a measuring apparatus and carry out potentiometric and voltametric measurements).
• analyse the measurement results obtained and determine kinetic and other parameters based on them.
• to use simulation software to obtain possible reaction mechanisms from the measurement data.
• to recognise sources of error in electrochemical experiments and to adapt the experiment.

Teaching and Learning Methods:
In the laboratory, the students learn the fundamentals of electrochemistry by carrying out experiments independently. In the process, students are directly supervised in small groups. In order to also gain a theoretical understanding of the underlying mechanisms and to learn the methods for analysing electrochemical measurement data, the analysis of the previously obtained data is carried out together. The theory is first discussed and then applied individually. Simple simulations are then carried out and the measurement results are compared quantitatively with the theory.
This inclusive approach should enable the knowledge to be conveyed as practically as possible, so that the students are then able to plan and carry out experiments independently and generate knowledge from them.

Media:
Slides, script, film, simulation software

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

Responsible for Module:
Prof. Nicolas Plumeré

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

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

Module Description

CS0207: Introduction to Electrochemistry | Einführung in die Elektrochemie

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Das Erreichen des Lernziels wird durch eine Klausur überprüft (Prüfungszeit: 60min). Auf die Note dieser schriftlichen Prüfung können bis zu 10% der Gesamtpunktzahl als Bonuspunkte angerechnet werden. Dabei legen die Ergebnisse der Onlinetests, die während des Semesters abgehalten werden, die Höhe der Bonuspunkte fest. Es müssen mindestens 65% der Punkte im Onlinetest erreicht werden, um Bonuspunkte zu erhalten. Dabei ist die Anhebung der Note von 4,3 oder schlechter auf 4,0 nicht möglich. Dies soll die Studierenden animieren kontinuierlich an den für sie sehr wichtigen Vorlesungen und Übungen teilzunehmen. Anhand von Fragen zu elektrochemischen Aspekten weisen die Studierenden nach, dass sie die entsprechenden Fachbegriffe, Bezeichnungen und Inhalte kennen, die grundlegenden Zusammenhänge verstanden haben und ihr Wissen über die ablaufenden Reaktionen im Rahmen der kinetischen und thermodynamischen Zusammenhänge anwenden können. Dazu werden konkrete rechnerische Aufgaben gestellt.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Erfolgreiche Teilnahme am Modul „Allgemeine Chemie“, „Physikalische Chemie“, „Mathematik“ und „Physik“ oder vergleichbare Kenntnisse.

Content:
- Konzepte der Elektrochemie: elektrochemische Thermodynamik (elektrochemisches Potential, Elektrodenpotential, Nernst Gleichung), Transport in Lösungen (Migration, Diffusion und Konvektion), Thermodynamik von Grenzflächen (die elektrochemische Doppelschicht), elektrochemische Kinetik.

- Aufbau einer elektrochemischen Messung und das Funktionsprinzip eines Potentiostats (Aufbau, Funktion und Anwendung).
- Stationäre Voltammetrie (Potentialsprung, lineare und zyklische Voltammetrie an Makro- und Mikroelektroden) für die Bestimmung von thermodynamischen und kinetischen Parametern.
- Mechanismen gekoppelter homogener Reaktion zur Energiekonversion und Elektrosynthese.
- Beispiele für die Anwendungen von Elektrochemie in realen Systemen (Gewinnung und Konversion erneuerbarer Energien, grüne Elektrosynthese).

Intended Learning Outcomes:
Die Studierenden erinnern das Basiswissen über fundamentale Konzepte der Elektrochemie und elektroanalytischen Chemie. Sie sind in der Lage, mit den generellen Prinzipien der Elektrochemie umzugehen und diese auf vereinfachte Probleme von realen elektrochemischen Systemen anzuwenden. Ein besonderer Fokus liegt hierbei auf dem Verständnis des allgemeinen und zeitlichen Zusammenspiels von Elektronentransfer, chemischen Reaktionen und Massentransport, welche die elektrochemische Antwort des Systems definieren. Des Weiteren sind die Studierenden vertraut mit industriell relevanten Prozessen und wie die Elektrochemie bei nachhaltiger Energiegewinnung und -speicherung helfen kann. Zusätzlich können sie die erlernte Theorie auf reale Beispiele aus Forschung und Industrie anwenden.

Teaching and Learning Methods:
In dieser Vorlesung werden die Lehrinhalte durch Vorträge des Dozenten anhand von Textdokumenten, PowerPoint-Präsentationen und Tafelbildern vermittelt. Dies ermöglicht eine detaillierte Darstellung des Lehrinhaltes und die Studierenden sind in der Lage Fragen zu stellen und zu diskutieren, sobald diese entstehen. PowerPoint Folien und Tafelbilder helfen als visuelle Unterstützung, um die komplexen Zusammenhänge in der Elektrochemie zu verstehen. Zusätzlich werden den Studierenden Übungsaufgaben zur Festigung des in der Vorlesung gelernten Inhaltes bereitgestellt. Die Lösungen dieser Übungsaufgaben werden später in einer Übungsstunde von den Studierenden präsentiert und diskutiert.

Media:
Präsentationen, Moodlekurs mit Onlinetests, Übungsblätter, Fragenkatalog, PowerPoint, Skript

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

Responsible for Module:
Prof. Nicolas Plumeré

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Elektrochemie (Übung) (Übung, 1 SWS)
Plumeré N [L], Moore Y

Einführung in die Elektrochemie (Vorlesung) (Vorlesung, 2 SWS)
Plumeré N [L], Moore Y, Plumeré N
For further information in this module, please click campus.tum.de or here.

Module Description

CS0209: Basics on Renewables Utilization | Grundlagen der Stofflichen Biomassenutzung

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Assessment takes a written examination (60 minutes), with students recall structure, transformation and use of different renewable resources. Students are required to answer questions using individual formulations and outline structures and reactions. In addition, sample calculations are to be worked out.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Introduction to various kinds of constituents of renewable resources: sugars, polysaccharides, fatty acids and oils, amino acids, proteins, terpenes, aromatics. Their structure, composition, distribution, characteristics, analytics and kind of added value, as well as their use will be introduced.

Intended Learning Outcomes:
After completion of the modules, students understand the chemical composition of renewable resources as well as their production and application. Using this knowledge students are able to explain the respective advantages and disadvantages as well as analyze the underlying physical, chemical and biotechnological principles of their conversion into valuable products.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations and case studies. Corresponding to the teaching content exercise sheets are

prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentation, script, examples and solutions

Reading List:
script, sample solutions for exercises

Responsible for Module:
Broder Rühmann

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

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

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Molecular biology and genetics

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

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

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

Media:
Slides, whiteboard

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

Responsible for Module:
Prof. Henrike Niederholtmeyer

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

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

Module Description

CS0222: Protein Chemistry | Protein Chemistry [ProtCh]

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
The learning results are proved in form of a written test (60 min exam duration). Based on questions to synthesis, purification, modification, analytics, characterisation and implementation of proteins the students prove that they know the corresponding technical terms, designations and contents, that they have understand the basic relations and are able to apply their knowledge. During the examination the tasks are set in both languages and the processing of the examination tasks can take place either in German or English.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the modules "Biochemistry" and "Practical course Biochemistry".

Content:
Basic principles of protein chemisty, chemical and biochemical protein synthesis, protein folding, amino acid analysis, posttranslational modifications, protein sequencing, prediction of secondary structures, tertiary structures, pI, determination of sulfylhydryl and disulfide groups, desalinisation, protein data bases, methods for protein immobilisation and labeling.
These fundamentals will solidify and broaden students’ knowledge in enzymology and enzyme catalysis, which represents a central building block in sustainable chemical synthesis, especially in the synthesis of biopharmaceuticals.

Intended Learning Outcomes:
After sucessful completion of the module the students are able to describe and explain basic concepts, phenomenons and relations in the field of protein chemistry. The students can describe biological and chemical methods of protein synthesis, purification and modification of proteins and

know how proteins can be characterised. In addition they can describe the impact of modifications on the protein structure or activity and apply their theoretical knowledge by means of questions.

Teaching and Learning Methods:
In the lecture the teaching content is imparted by speech of the lecturer using powerpoint presentations and blackboard sketches. Corresponding to the teaching content exercise sheets are prepared on which the students work in self-study. The solution and discussion of the exercises takes place in the tutorial.

Media:
Presentations, PowerPoint, script, exercise sheets

Reading List:
Bioanalytik, F. Lottspeich, H. Zorbas, Spektrum Akademischer Verlag
Voet, D. , Voet, J.G., Biochemistry 4th Edition, Wiley-VCH, 2011; Nelson, D.L, Cox, M.M., Lehninger Principles of Biochemistry 5th Edition, WH Freeman, 2008; Berg, J.M, Tymoczko, J.L., Stryer, L., Biochemistry 6th Edition, 2006

Responsible for Module:
Prof. Volker Sieber Ammar Al-Shameri

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

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

Module Description

CS0131: Applied Methods in Chemistry | Praktische Methoden in der Chemie

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Exam achievement shall be done in the form of laboratory performance (e.g. preparation, performance (ca. 15 experiments depending on topic) and written evaluation (ca. 20 pages)) combined with a ten-minute presentation. Thus it shall be demonstrated that the working methods learned can be applied practically and transferred to the execution of test series. By means of the presentation communicative competence shall be verified when scientific topics are presented in front of an audience. Laboratory performance shall be evaluated with 2/3, the presentation with 1/3.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge and laboratory experience like in the modules of WZ1922/WZ1925 (LV4390 General and inorganic Chemistry und LV4400 Practical Laboratory Course General and inorganic Chemistry) and WZ1924/CS0215 (LV972 Organic Chemistry und LV936 Practical course in organic chemistry) shall be imparted.

Content:
The module makes use of different methods leading to the performance of test series. As a first step the students shall be lead to planning and performance of basic activities of laboratory practice by means of the lecture including thematisation of experiment design and research of literature as well as keeping the laboratory journal, how to use the most important and basic practical working methods as well as handling the most import laboratory equipment. In the next step the different working methods (including weighing, dissolving, diluting) shall be applied in supervised practical exercises. Subsequently individual test series shall be planned, processed and evaluated by the students after consultation with the lecturer.

Intended Learning Outcomes:
After having participated in the module units the students are capable of using basic working techniques (such as weighing, pipetting, dissolving, diluting) in the laboratory, of outlining simple test series, of performing an experimental design and of recognizing possible sources of errors.

Teaching and Learning Methods:
The module is successively built up using lecture, practical exercises and test series. In the lectures it is dealt with basic issues and methods necessary for the execution of subsequent exercises. After testing different methods in supervised exercises these methods will be transferred to a test series. Planning, performance and result evaluation will be summarised in a written assessment.

Media:
PowerPoint, Laboratory

Reading List:
Organikum, Lehrbuch der analytischen und präparativen anorganischen Chemie (Organikum, Textbook of Analytical and Preparative Anorganic Chemistry) (ISBN 978-3527339686) ; 1x1 der Laborpraxis (Basics of Laboratory Practice (ISBN 978-3527316571)

Responsible for Module:
Dr. Corinna Urmann

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester

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

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

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

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

Media:
Blackboard, slides

Reading List:

Responsible for Module:
Dr. Daniel van Opdenbosch

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

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

Module Description

CS0106: Introduction to Graphs and Networks | Einführung in Graphen und Netzwerke [EGN]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Assessment takes an oral form (25 minutes). Students show the extent to which they have understood the taught definitions and terminology from the field of graphs and networks. They show to which extend they are able to use networks in order to model problems from science and engineering. They are also expected to use appropriate methods to solve fundamental optimization problems on networks. Students demonstrate their understanding of these methods when answering comprehension questions.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Module Mathematics (WZ1601) or Advanced Mathematics 1 (CS0175)

Content:
Directed and undirected graphs and networks, paths and cycles, connected components, minimum spanning tree problem, shortest path problem, Prim's algorithm, Kruskal's algorithm, Dijkstra's algorithm, matchings, Modeling with graphs and networks

Intended Learning Outcomes:
Students have aquired basic theoretical and practical knowledge in the field of graphs and networks. They know the basic definitions and terminology and are able to use networks in order to model problems from science and engineering. Students know fundamental optimization problems on networks such as the minimum spanning tree problem or the shortest path problem as well as the most important methods for solving these problems. They have gained a good understanding of these methods, can choose appropriate methods among them, and can apply these to case examples.

Teaching and Learning Methods:
Lectures introduce basic knowledge; tutorials practice modelling using networks and the application of methods for solving optimization problems on networks.

Media:
Lectures given as presentations (projector and/oder blackboard), tutorials with group work and exercise sheets

Reading List:
André Krischke und Helge Röpke - Graphen und Netzwerktheorie, Carl Hanser Verlag, 2015.
Sven Krumke und Hartmut Noltemeier - Graphentheoretische Konzepte und Algorithmen, 3. Auflage, Vieweg+Teubner Verlag, 2012.
Ravindra Ahuja, Thomas Magnanti, James Orlin - Network Flows, Prentice Hall, 1993.

Responsible for Module:
Prof. Clemens Thielen

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

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

Module Description

CS0302: Research Internship Bachelor | Research Internship Bachelor

Version of module description: Gültig ab summerterm 2024

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

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:
alle prüfungsberechtigten Personen des TUMCS

Courses (Type of course, Weekly hours per semester), Instructor:
Research Internship Bachelor (Costa) (Forschungspraktikum, 5 SWS)
Costa Riquelme R [L], Atoini Y, Banda Vazquez J, Costa Riquelme R, Gutierrez Armayor D, Lipinski S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0304: Research Excursion Bachelor | Research Excursion Bachelor

B-REX

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
Passed/not passed:
The module is passed when the deliver a learning portfolio consisting of the following elements:
1. 2 written pages or 20’ presentationon preparatory work for the excursion. The form and the due date will be specified in the kick-off session.
2. At least two topical contributions to the excursion (topical input, interviews, questions on presentations and during site visits, discussion contributions);
3. 2 written pages reflection after excursion. The due date will be specified in the kick-off session.
All three elements of the learning portfolio have to be delivered to pass the module.

Repeat Examination:

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

Content:
The research excursion deals with individual and specific topics from the respective study programmes. On an individual basis, professors and lecturerers from the rerspective study programme offer the research excursion to a topic or place of their choice.

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

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

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

Teaching and Learning Methods:
The research excursion consists typically of the following elements (teaching and learning methods):
- Kick-off session: To achieve a good get-to-know, brief the students about the research excursion contents, related courses and required student performance an interactive in-presence workshop will be carried out. This covers prsentations, and interactive elements such as games, online-tools etc.
- Individual work and feedback: In order to prepare for the on-site visits the students carry out own (literature) research on the excursion topics. To document their learning progress and to be able to share the results they summarize their findings in written form. A presentation of the contents in front of the fellow students is an optional element. In this process, they are supervised, receive materials and continuous feedback.
- On-site visits: 3-5 day research trip with site-visits, presentations, discussions with stakeholders etc.This part will be specified in the specific program of the research excursion and can due to the variety of possible destinations and topics not be specified further at this point.
- Individual work: the students will reflect their learnings in written form.

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

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

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

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

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

Module Description

CS0328: Nobel Concepts toward Sustainable Future | Nobel Concepts toward Sustainable Future

Version of module description: Gültig ab summerterm 2025

Module Level: Bachelor	**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 in the exam the understanding of the physicochemical, biological, and engineering concepts of high relevance for a sustainable future. They will be asked about basic concepts of biology, chemistry, physics, and engineering applied to technology, building, management, economy, etc. No auxiliary means are allowed in the exam. 120 min examination time

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
This course will intend to consolidate basic concepts in Physics, Biology, Chemistry, Management, Engineering and Mathematics having the focus on examples highlighted by the Nobel Laurates. As such, basic knowledge in Physics, Biology, Chemistry, Engineering, Management, Economics, and Mathematics is required.

Content:
The module aims at providing in-depth knowledge to the students in the field of Physics, Chemistry, Biology, Materials Science applied to technologies (energy transformation, thermal management, storage, lighting, etc.). The focus on basic physical, mathematical, biological and chemical laws, concepts, principles and processes, including chemical bonding, chemical kinetics, spectroscopy, thermodynamics, thermochemistry, mechanics, optics, among others. The students will be able to apply them to understand the functionality of concepts highlighted by the Nobel Laureate toward the transformation of a more sustainable society under the frame of the United Nations Global Sustainable Development Goals.
The course will be divided into several topics related to the chemical transformation, biological transformation, evolution, climate change, management and supply, physical concepts,

engineering, mechanics, and electrical control. Each topic will be addressed refreshing the most important physical, biological, management, engineering and chemical concepts followed by their relevance in the structural and functional aspects towards the sustainable transition of our society.

Intended Learning Outcomes:
Increase students' knowledge of the 17 Global Goals and show the contributions of several Nobel Laureates to sustainable development. At the end of the module students will be able to analyse chemical, mathematical, physical, and biological concepts that are relevant for sustainable transformation of our current technologies; describe the different ways our society is transformed using sustainable concepts (thermally, optically, mechanical, chemistry, biology, water, economics, etc.) that have been highlighted as relevant Nobel Laureates. They will be able to apply these concepts to understand the limitations and challenges related to the sustainable transformation of our technological society. This course will enable students to discuss the United Nations Global Sustainable Development Goals from an interdisciplinary perspective.

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

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

Reading List:
1. Physical Chemistry for the Biological Sciences, 2nd Edition Gordon G. Hammes, Sharon Hammes-Schiffer, Wiley, 2015, ISBN: 978-1-118-85900-1
2. Physical Chemistry for the Life Sciences, 2ndEdition Peter Atkins and Julio De Paula Oxford University Press ISBN: 978-0-19-956428-6
3. Concept Mapping 4 Concepts of Nobel Prize in Physics 2018, ISBN: 1729234488

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

Courses (Type of course, Weekly hours per semester), Instructor:
Nobel Concepts toward Sustainable Future (Exercise) (Übung, 2 SWS)
Atoini Y, Banda Vazquez J, Costa Riquelme R, Lipinski S

Nobel Concepts toward Sustainable Future (Lecture) (Vorlesung, 2 SWS)
Atoini Y, Banda Vazquez J, Costa Riquelme R, Lipinski S
For further information in this module, please click campus.tum.de or here.

Module Description

MW2374: Introduction to Bioengineering: Bio-inspired Material Design | Einführung ins Bioengineering: Biologisch inspirierte Materialentwicklung [BIMD]

Version of module description: Gültig ab summerterm 2025

Module Level: Bachelor	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 108	**Self-study Hours:** 63	**Contact Hours:** 45

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

Description of Examination Method:
The grade of the module will be determined from a written exam (duration: 60 min); for the written exam, only a non-programmable calculator is allowed as an aide. In the written exam, the students demonstrate whether they understand basic concepts of bionics and of surface-related material properties and if they can apply those concepts to real-life problems. By solving mathematical problems and case examples, the students show if they can develop bionic/bio-inspired solutions and strategies, for example, for the development of novel (semi-) synthetic materials and if they can assess differences in material properties that are affected by both, biological variance and experimental errors. By giving a short (voluntary) pitch and poster presentation (mid-term achievement), the students can demonstrate whether they are capable of performing a literature and patent search, if they can assess the suitability of biological examples for creating artificial materials and if they can prepare and present a „selling pitch“ and a “pitch board”. Furthermore, the students will demonstrate their ability to present their approach to a non-specialist audience in a technically as well as rhetorically comprehensible manner. This additional examination in form of a pitch and poster presentation is chosen since only this method allows for testing a student’s competence to acquire knowledge in a certain amount of time, to present it in an understandable way and to explain how the solution they present has been inspired by bionic/biological principles. Here, the students also apply knowledge regarding suitable presentation techniques, which they were taught by the Center of Key Competencies in the framework of this module. If this pitch and poster presentation with compulsory attendence (mid-term achievement) is successfully held by the students, the received grade from the final exam will contribute 100 % to the overall module grade, but a grade-bonus (0,3 or 0,4) will be subtracted from the exam grade. Otherwise, the written exam constitutes 100 % of the final module grade. In any case, for passing the module, the final exam needs to be passed with a grade of 4,0 or better; improving the exam grade to obtain a final grade of 4,0 is not possible – neither is an improvement of the exam grade to a final

grade better than 1,0. The detailed criteria to be met so that the mid-term achievement is rated as “successful” will be explained during the first lecture of this module.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in physics and chemistry (high school level) is required.

Content:
This lecture covers phenomena that take place on the surface of materials or at the interface between two materials. First, the principles of bionics and bio-inspired engineering will be introduced. Then, the following topics (among others) are discussed: surface wetting resistance (superhydrophobicity), anti-adhesive surfaces, friction and lubrication by water-based lubricants, self-lubricating materials, the generation and prevention of wear as well as origins of biofouling and strategies for preventing this phenomenon. For each topic covered by this lecture, a biological model is discussed, which shows how the particular material property can be achieved. Following this introduction of biological examples, artificial, (semi-)synthetic materials are discussed whose development was inspired by biological models. Examples of technical or medical applications of such bionic/bio-inspired materials include hydrophobic building materials (mortar, cement), water collecting devices from fog, molecular coatings for increased wearing comfort of contact lenses, and synthetic cartilage replacement materials.

Intended Learning Outcomes:
After successful completion of the course „bio-inspired material design“ students are able to: understand and apply basic concepts of bionics and of surface-related material properties such as wetting, friction, lubrication, wear, and biofouling; independently create simple approaches for the development of novel (semi-) synthetic materials that are intended to solve a biomedical or technical problem and make use of bionic/bio-inspired principles; perform literature and patent searches and extract relevant information from those files; understandably present their approach and the benefits of the novel material they propose to a non-specialist audience in a short pitch and poster presentation; assess the suitability of different biological materials as role models for the material they suggest to develop; understand the basics of error calculation approaches and significance analyses and compare material properties which are affected both by biological variability and experimental uncertainties.

Teaching and Learning Methods:
The module comprises a lecture and a tutorial. In the lecture, PowerPoint presentations will be used to present the theoretical background required for the development of bionic/biologically inspired materials and their properties such as wetting, friction, lubrication, wear and biofouling, as well as the principles of experimental uncertainty quantification (error calculation methods). Videos will be used to illustrate the basic concepts of selected material properties. This will help deepening

the understanding of the topics covered and will also illustrate the applicability of the presented materials and their relevance for research, industry and every-day life. The lecture slides will be available online for download in advance of each class so that the students can manually add comments to the lecture slide print-outs during class. Additionally, schemes will be drawn on the blackboard to clarify certain concepts. In the tutorial, which will take place as individual workshops, methods and tools for preparing and presenting an idea suitable for the development of a novel bionic/bio-inspired material will be taught and explained. These methods include a literature and patent research, methods to assess the properties of biological materials in the context of biological variability and measurement errors, as well as methods to create a short „selling pitch“ and “pitch board”. During the semester, the students will develop such a 2-minute „selling pitch“ and a “pitch board” in small groups. They will receive input on suitable methods for those two items from the Center of Key Competencies. At the end of the semester, those “selling pitches” and “pitch boards” will be presented by the students in the framework of another workshop.

Media:
Power point presentation, short movies in English to visualize selected phenomena, digital questions to repeat key content of the previous lecture at the beginning of each lecture (anonymous, “popular voting” with Pingo)

Reading List:
The lecture slides are made available through Moodle. Relevant additional literature is listed on those slides.

Bushan, B. and Nosonovsky, M., The rose petal effect and the modes of superhydrophobicity, Philosophical Transactions of the Royal Society A, 368(1929), 4713-4728 (2010)

T. Crouzier, K. Boettcher, A.R. Geonnotti, N.L. Kavanaugh, J.B. Hirsch, K. Ribbeck, and O. Lieleg, Modulating Mucin Hydration and Lubrication by Deglycosilation and Polyethylene Glycol Binding, Advanced Materials Interfaces. 2 (18) 1500308 (2015)

Responsible for Module:
Oliver Lieleg, Prof. Dr. Contact for lectures/ students lehre.bme@ed.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

WZ1687: Introduction to Medicinal and Spice Plants | Einführung in die Heil- und Gewürzpflanzen [MSP]

Version of module description: Gültig ab winterterm 2015/16

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

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

Description of Examination Method:
In an written exam the students shall demonstrate that they recognize the most important medical and spice plants from the European area. They shall demonstrate that they are able to explain cultivation methods as well as harvest and drying. They shall be able to represent the ingredients of medical and spice plants and medical effect by using examples. Type of exam: written, Exam Duration: 60 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Organic and Inorganic Chemistry, Botanics, Plant Production

Content:
Medicinal herbs history, presenting medical and spice plants, setting up of a herbarium, aspects of plant production for creating herb fields, their crop protection and harvest. Techniques for herb drying. Classes of agents such as terpenes, steroids, coumarins, alkaloids, vitamins, flavonoids. Connection between classes of agents and their medical effect. Basic mechanism of action of different classes of agents. Typical medicinal plants from European cultivated areas. Modern cultivation and use of medicinal plants in practice.

Intended Learning Outcomes:
After having participated in the module units the students are able to recognize medical and spice plants. They know basis of plant production for setting up a spice garden or fields. They know process technology basics for spice drying. They are able to designate the most important classes of agents. The students are able to call up connection between medical effect and chemical classes of agents by using typical examples. By having participated in the exercises in the spice

garden and laboratory work they are able to use simple analytical-chemical activities relating to plant analysis or assess their results.

Teaching and Learning Methods:
Lecture, speech by teaching staff by using PP media, books and other written material, setting up of a herbarium, study trip to a herb drying company. Exercise (e.g. Experimentation of students under supervision). Excursion on research fields (LfL) in Manching. Determine Herbs in a garden.

Media:
PP presentations and printed versions as documents. Laboratory equipment for experimentation, ready-made exercise analyses. Herbs for a determination and view on etheric oils.

Reading List:
Deutschmann, F., Hohmann, B., Sprecher, E., Stahl, E., Pharmazeutische Biologie (Pharmaceutical Biology), 3 volumes, G. Fischer Verlag, 1992
Wendelberger, E., Heilpflanzen (Medicinal Plants): Erkennen | Sammeln | Anwenden (Recognising | Collecting | Using) (paperback – BLV Buchverlag Januar 2013

Responsible for Module:
Corinna Urmann (alexander.hoeldrich@tum.de)

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

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

General Education Modules | Allgemeinbildende Wahlmodule

Module Description

CS0272: Experimental Lab - Architecture, Science & Design | Experimental Lab - Architektur, Wissenschaft & Design

Version of module description: Gültig ab winterterm 2025/26

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

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

Description of Examination Method:
Over the course of the semester, students are expected to complete a project assignment. The focus is on developing an understanding of architecture and design in the context of scientific topics – students develop their own ideas for the public urban space. The final grade is based on the project work and a concluding semester presentation. The evaluation takes into account the idea, function, context, creative development of the concepts, and the manner of presentation. Type of examination: oral (presentation); Duration: 30 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The content of this module is divided into three main focus areas:

The first focus is an introduction and a joint “Mind Opening Workshop” exploring the interplay between architecture, science, and design. In addition, students are introduced to the fundamentals of visual communication, which are intended to support them in developing and delivering their own presentations in the future.

A second focus is the teaching of basic knowledge and an overview of the broad spectrum of the field of architecture. This is achieved through lectures as well as by applying transfer techniques in the students' own project work. The complex perception of renewable raw materials in both private

and public spaces is addressed, along with the wide range of possible applications. The aim is to stimulate students' creativity and encourage them to place science and research in the context of other disciplines. This synergy effect is intended to inspire innovative approaches and open up new areas of tension and research.

The third focus is the implementation of the learned methods and approaches in the students' own project in public space, where the diverse possibilities for the use of renewable raw materials are to be made tangible. Communication about the insights and outcomes within the course and to the public is another key component of the module. The goal is to enhance students' presentation skills and techniques in order to effectively realize and communicate their own ideas.

Intended Learning Outcomes:
After completing the module, students are able to understand the fundamentals and methods of architecture and design and relate them to scientific topics. The experiences gained through the coursework and project work enable students to develop their own creative solutions with an interdisciplinary approach. Through regular feedback during the course, students learn various techniques and methods for planning engaging presentations and delivering them convincingly.

Teaching and Learning Methods:
Depending on the size of the course, students complete and present a project on a specific topic either individually or in groups. The results are presented within the course and/or in a public setting. Additional methods include lectures on architecture and design, project work involving constructive, mutual exchange, and a final presentation.

Media:
Use of all available multimedia resources

Reading List:
The most up-to-date literature recommendations will be provided to students during the module introduction.

Responsible for Module:
Verena Stierstorfer

Courses (Type of course, Weekly hours per semester), Instructor:
Experimental Lab - Spannungsfeld Architektur, Wissenschaft & Design (Projekt, 2 SWS)
Stierstorfer V
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:
(SOT86061) Data Regulation & Law (part of 6 ECTS module) (Übung, 2 SWS)
Paal B (Djebbari S, Krikis K)

(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

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

Seminar to Children, Well-Being, and Digital Technologies (Seminar, 2 SWS)
Cortesi S, Hidalgo Avila C

Workshop: Children, Well-Being, and Digital Technologies (Übung, 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) Risk & Crisis Communication (part of 6 ECTS module) (Seminar, 2 SWS)
Walter S

(SOT86080, SOT86102) Risk & Crisis Communication: Theories and beyond (Vorlesung, 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 2) (Seminar, 2 SWS)
Ohlhorst D

(POL23200) Umweltpolitik im internationalen Vergleich (Seminar 1) (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.

Module Description

SOT82701: EuroTeQ Collider. Enhancing Connections for Sustainable Futures (BSc) | EuroTeQ Collider. Enhancing Connections for Sustainable Futures (BSc)

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
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:
End of 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 write 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 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:
- Use disciplinary knowledge and expertise in an inter-disciplinary team to address challenges in a European context.
- Search for appropriate design, engineering and business approaches and tools to build solutions to a real-life challenge.
- Communicate your results, via several mediums in an international context.

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 final 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.

Bachelor's Thesis | Bachelor's Thesis

Module Description

CS0054: Bachelor's Thesis | Bachelor's Thesis

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester / End of Semester

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

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

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

Teaching and Learning Methods:
During the Bachelor´s Thesis, the students work on a scientific problem. At this juncture amongst others literature research as well as lab work and presentations are used. The actual teaching and learning methods depend on the respective problem and have to be discussed with the supervisor for each single case.

Media:
Specialist literature, software and so on

Reading List:
in consultation with the supervisor

Responsible for Module:
Prof. Cordt Zollfrank

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

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

Alphabetical Index

A

B

C

D

E

F

G

H

I

L

M

N

O

P

R

S

T

V

W