# Module Catalog

*B.Sc. Sustainable Management and Technology*
Degree Program B.Sc. Sustainable Management and Technology
Technische Universität München

www.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 143

# Required Modules | Required Modules

## Module Description

## CS0063: Microeconomics | Microeconomics [Micro I]

Version of module description: Gültig ab winterterm 2023/24

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>120 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
In the exam (written, 120 minutes) students should demonstrate their ability to adequately interpret the microeconomic concepts and apply the methods worked on in class. By means of multiple-choice-questions, which are either embedded in a context/case/scenario or require prior computation, students' capacity to apply the learned solution strategies to new settings and draw correct economic implications is assessed. A non-programmable calculator is allowed.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**

**Content:**
This course provides an introduction to basic concepts of microeconomics. To understand how a transition towards a more sustainable economy is possible we first have to understand the basic mechanisms in the economy. To this end, this lecture investigates the behavior of individual economic units, such as households, business firms, and public institutions. Another concern is how these units interact to form markets and industries. How can consumer decisions be explained and how can aggregate demand be derived from consumer choice? Which are the factors that determine the production decisions of companies? How do equilibrium prices emerge in competitive markets, how in monopoly markets? What is the effect of government interventions in markets (e.g. green taxes, price controls)? How does market power affect social welfare? Which factors lead to market failure?

**Intended Learning Outcomes:**
After attending this module, students will be able to describe economic tradeoffs (particularly in choice under scarcity situations of consumers and firms). Moreover, they know strategies to solve those tradeoffs and are capable of applying them to new situations. Students are able to explain the fundamental economic mechanisms underlying specialisation and trade (particularly in view of technological progress). Students can predict how government interventions (e.g. carbon taxes, price controls) will affect simple competitive markets. They are able to explain why certain industries are prone to market concentration and how market power affects social welfare. They can distinguish which types of goods are efficiently provided on free markets and which not.

**Teaching and Learning Methods:**
An interactive lecture introduces essential microeconomic concepts and theories and illustrates them with the help of topical empirical examples. Classroom experiments complement the classic bird-eye's perspective by nudging students to put themselves in the positition of particular economic players, thereby requiring them to actively reflect the concepts introduced. Online surveys at the end of each chapter enable students to select which topics they would like to intensify in subsequent classes. In the accompaying exercise class, students practice, on specific problems and examples, the mathematical techniques needed to develop a deeper understanding of the economic concepts. In self-study students use the textbook to repeat the concepts introduced in class and apply them to additional examples.

**Media:**
Textbook, slides, exercise sheets, classroom experiments, online surveys

**Reading List:**
Robert S. Pindyck and David L. Rubinfeld, Microeconomics, 8th Edition, Pearson, 2013 (ISBN 13: 978-0-13-285712-3). AND Robert S. Pindyck und David L. Rubinfeld, Mikroökonomie, 8. Aufl., Pearson Studium, 2013 (ISBN-13: 978-3868941678).

**Responsible for Module:**
Prof. Sebastian Goerg

**Courses (Type of course, Weekly hours per semester), Instructor:**
Economics I am Campus Straubing (Microeconomics) (Vorlesung, 2 SWS)
Goerg S [L], Goerg S

Economics I - Übung am Campus Straubing (Übung, 2 SWS)
Goerg S [L], Speckner M
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0075: Management Science | Management Science [ManSci]

Version of module description: Gültig ab winterterm 2024/25

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|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>120 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
Students mastery of the content taught in this module is checked with a 60 minutes written and multiple-choice exam. In the written part of the exam students have to answer questions, apply algorithms to solve problems, create mathematical models for small example problems, and discuss presented results. By this, the students have to demonstrate that they have understood and can apply the mathematical models and methods to solve business planning problems. The multiple-choice questions allow to check if students also understood other parts of the lecture that could not be included in the written part. This will be used to assess if fundamental aspects in Management Science can be evaluated. The overall grade of the module is based on the result obtained in the written and multiple-choice exam. Students are only allowed to use a non-programmable calculator.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Knowledge of Mathematics and Statistics at the level as definend in the German Abitur

**Content:**
Management Science is about modelling, solving and analysing planning and decision problems using mathematical concepts. Management Science is used across different industries, departments and organizations. The lecture will treat the Management Science approach to decision making in general and the following topics in particular: Linear Programming, Mixed-Integer Programming, Graph Theory, Network Flow, Dynamic Programming and Decision Theory.

**Intended Learning Outcomes:**
After successful completion of the module, students are capable of modelling planning problems. They are able to solve small business problems manually by using models and methods of linear

and integer programming, of graph theory, of network flow, of dynamic programming, and of decision theory.

**Teaching and Learning Methods:**
The module consists of a lecture and exercise courses, which are provided weekly, as well as a voluntary tutorial offered. In the lecture, the content is jointly developed with the students mainly by using slides. The exercise course repeats parts of the lecture contents by using examples. The tutorials are delivered by student teaching assistants for smaller groups which gives the student the opportunity to pose questions and receive immediately help from the teaching assistant.

**Media:**
Script, Presentation slides

**Reading List:**
Bradley, S.P., A.C. Hax und T.L. Magnanti: Applied Mathematical Programming, Addison-Wesley, 1977.
Domschke W and A. Drexl: Einführung in Operations Research, 9th Ed., Springer, 2015.
Hillier FS and Lieberman GJ: Introduction to Operations Research, 9th ed., McGraw-Hill, 2010.
Winston WL: Operations Research, 5th Ed., Thomson, 2004.

**Responsible for Module:**
Prof. Alexander Hübner

**Courses (Type of course, Weekly hours per semester), Instructor:**
Management Science Lecture - Campus Straubing (Vorlesung, 2 SWS)
Hübner A [L], Schäfer F

Management Science Exercise - Campus Straubing (Übung, 2 SWS)
Hübner A [L], Schäfer F
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0193: Foundations of Sustainable, Entrepreneurial & Ethical Business | Foundations of Sustainable, Entrepreneurial & Ethical Business

Version of module description: Gültig ab winterterm 2023/24

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>120 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
The examination performance will be in the form of a written exam (120 minutes). The written exam provides a comprehensive assessment of whether students know and understand the basic principles of entrepreneurship and sustainability. They answer questions about the concepts that explain the mindset of entrepreneurial individuals and the management of entrepreneurial firms. They also answer questions about basic definitions of specific types of entrepreneurship and entrepreneurial behavior related to environmental and social problems. In addition, students will be assessed on their knowledge of basic principles and models of ethical economic behavior and their ability to use and develop knowledge of entrepreneurship. They answer questions on basic definitions and theories of ethical behavior and evaluate ethical behavior in an economic context.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**

**Content:**
The module introduces students into basic principles of the topic of entrepreneurship from a global and sustainability perspective. Students will be equipped with basic knowledge on:
- definitions, regional aspects, and special forms of entrepreneurship
- understanding of ecological and social problems and entrepreneurial approaches to solving them
- entrepreneurial individuals, including their personality, creativity, idea development, cognition, opportunity recognition, decision making, affect, and moving forward from failure
- entrepreneurial firms, including their growth strategies, strategic alliances, and resources.

Beyond that, students will engage in break-out group workshops to personally experience the process of opportunity recognition and development. In these workshops, teams apply concepts from the academic literature to real-world business issues to solve environmental and/or social problems. Furthermore, students give presentations to the audience and discuss their results.
In addition, the module introduces basic problems, arguments, and theoretical approaches of business ethics. It investigates the chances of realizing moral norms at the interception of entrepreneurship/economics and ethics. Basic is the analysis of ethical decision processes in corporations and the detailed investigation of situations and alternatives of action. Topics involve reputation, trust and social capital as well as corruption, environmental protection, and global ethical concepts. This part ends with a critical discussion of different research approaches in the debate on business ethics.

**Intended Learning Outcomes:**
Students know basic concepts of entrepreneurship and sustainability including basic definitions, psychological processes and characteristics of entrepreneurs as well as possible development paths of entrepreneurial firms and are able to explain them. Furthermore, students transform and apply this knowledge to real cases. They are able to find entrepreneurial solutions for ecological and/or social problems in real cases, taking into account the theories of entrepreneurial processes.

Furthermore, students understand the ethical significance of economic theories, reflect on ethical aspects in economics and apply ethical theories in an economic, social and ecological context. Students are able to draw conclusions from the known theories and concepts and to behave ethically in everyday business life.

**Teaching and Learning Methods:**
The module combines several learning methods.
- The basic knowledge as well as real world examples will be provided through the lecture.
- Discussions in the lecture and active participation are encouraged and will contribute to deepen the understanding of the concepts introduced.
- Workshops in smaller groups enable the students to apply (part of) their theoretical knowledge to real-world problems. This format additionally fosters creativity and team work.
- Students will get additional background knowledge from the scientific literature in private reading.

**Media:**
Presentations and PowerPoint slides

**Reading List:**
Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2010). Entrepreneurship (8th ed.). New York: McGraw-Hill.
Read, S., Sarasvathy, S., Dew, N., Wiltbank, R. & Ohlsson, A.-V. (2010). Effectual Entrepreneurship. New York: Routledge Chapman & Hall.
Lütge, C., Uhl, M. (2018). Wirtschaftsethik. München: Vahlen.
Crane, A., Matten, D., Glozer, S., Spence, L. (2019): Business Ethics. Oxford: Oxford University Press

**Responsible for Module:**
Prof. Claudia Doblinger

**Courses (Type of course, Weekly hours per semester), Instructor:**
Introduction to Entrepreneurship (Vorlesung, 2 SWS)
Doblinger C [L], Doblinger C, Fischer D

Introduction to Business Ethics (Vorlesung, 2 SWS)
Doblinger C [L], Krinner S
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0194: Mathematics | Mathematics

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
Learning outcomes shall be verified in a written test (90 min). Tasks shall be specified by means of which the students are to demonstrate that they know the mathematical methods imparted as part of the module and that they have understood and are able to apply them for specific case studies.

**Repeat Examination:**
End of Semester

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

**Content:**
Selected mathematical methods required for calculations in the scientific, engineering, and economic areas, as well as areas of sustainability, including analysis (e.g. mathematical induction, differential and integral calculus, sequences and series), calculations with real and complex numbers as well as selected chapters of linear algebra (e.g. linear equation systems, matrices, inverse matrices, determinant, eigenvalues and eigenvectors). The methods are introduced in the lecture. In the exercises, their application is practiced on concrete case studies, including examples with relevance to sustainability.

**Intended Learning Outcomes:**
The students know the most important mathematical methods required for calculations in the scientific, engineering, and economic field, as well as areas of sustainability. They have understood these methods and are able to calculate specific case studies and perform basic mathematical proof by means of complete induction.

**Teaching and Learning Methods:**
Lecture, presentation, and associated exercises with independent processing and teamwork of specific examples. Mathematical methods shall be presented during the lecture. Within the scope of the exercise, their application shall be practiced based on specific case studies.

**Media:**
Digital presentation, writing on the board, exercise sheets

**Reading List:**
Calculus and Linear Algebra in Recipes. Christian Karpfinger, Springer-Verlag 2022

**Responsible for Module:**
Prof. Dominik Grimm

**Courses (Type of course, Weekly hours per semester), Instructor:**
Mathematics (Lecture) (Vorlesung, 2 SWS)
Grimm D [L], Grimm D

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

# Module Description

## CS0199: Statistics | Statistics

Version of module description: Gültig ab winterterm 2023/24

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

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

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

**Repeat Examination:**
End of Semester

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

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

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

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

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

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

**Responsible for Module:**
Prof. Clemens Thielen

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

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

# Module Description

## CS0067: Macroeconomics | Macroeconomics [Macro I]

Version of module description: Gültig ab winterterm 2021/22

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

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

**Description of Examination Method:**
The exam will be a written test (120 min.) at the end of the term. The exam is designed to assess the participants' capabilities to apply macroeconomic theory in order to discuss and solve real world problems of the economy as a whole. Participants should demonstrate their capacity for abstraction (thinking in economic models), concretization (calculating, interpreting and applying the results of the model, mathematical processing as well as graphical illustration.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**

**Content:**
This module provides an introduction to basic concepts of macroeconomics. It covers:
- key institutions of capitalism as an economic system (private property, firms, markets)
- technological change as a trigger for economic growth
- price-taking and competitive markets
- price-setting, rent-seeking and market disequilibuium
- market successes and failures
- markets, contracts and information
- credit, banks and money
- economic fluctuations and unemployment
- unemployment, inflation, fiscal and monetary policy
- technological progress and living standards
- the Great Depression, the golden age of capitalism and the global financial crisis

**Intended Learning Outcomes:**
After attending the module, students will able to describe the composition and distribution of the Gross Domestic Product. They can analyze the economic mechanisms underlying unemployment as well as issues regarding monetary policy and inflation. Further, participants will learn to understand the economic crisis and the wealth differences among nations. Students are enabled to think in models and apply mathematical solutions when approaching economic problems.

**Teaching and Learning Methods:**
The module consists of a lecture and an exercise course. The lecture content will be delivered in a verbal presentation with the help of slides. Since the foundation of the lecture is a textbook including recent economic history, the teaching is full of real life examples. The content of the lecture is put into practice in the exercise course which applies the theoretical knowledge by basic mathematical calculations and graphical illustrations. Therefore, the module aims at encouraging participants to independently think about economic problems discussed in the lecture and in the current literature. Students are enabled to use the instruments (abstract and model thinking) for operationalizing economic problems and solve them in the conventional, mathematical manner.

This module is also offered at TUM Campus Straubing.

**Media:**
http://www.core-econ.org/

**Reading List:**
The CORE Project (2016): 'The Economy', in: Azm Premji University, Friends Provident Foundation, HM Treasury, Institute for New Economic Thinking, Open Society Foundations, SciencesPo, UCL (eds.), University College London.

**Responsible for Module:**
Prof. Andreas Pondorfer

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

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

# Module Description

## CS0196: Sustainable Operations | Sustainable Operations

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
The module examination consists of a written exam (90 min.). Permitted tool is a non-programmable calculator.
In the written exam, students demonstrate that they can apply various approaches to problem solving, building on their understanding of production and logistics planning in general. Using exemplary tasks from production or logistics planning, students demonstrate that they can interpret planning problems as well as relationships between different problems. Based on this, students will provide recommendations for a solution to these problems.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Fundamentals of Mathematics and Management Science are recommended

**Content:**
This is a basic module in which an overview of planning problems in production and logistics and methodologies for solving them will be developed. Students are familiarized with different levels of planning hierarchy (strategic, tactical, operational) and the planning problems at each level. Heuristics and additionally simple models of linear and mixed-integer programming are discussed and applied as methodologies for solving the planning problems in the area of production and in the area of logistics. The module includes these parts, among others:
- Strategic planning problems: e.g. location planning
- Tactical planning: designing the infrastructure of different production systems (workshop production, flow production, production centers)
- Operational planning problems: Demand forecasting models, main production program planning
- Material requirements planning

- Resource scheduling and control: lot size planning, machine scheduling planning, line-up sequences for flow production
- Transportation logistics: planning problems for determining tours, routes and packing schemes
- Material logistics: policies for inventory management and their extension to stochastic demands; strategic design of the logistics network; interfaces with predecessor or successor companies
- Procurement logistics: methods for the selection of suppliers
- Distribution logistics: setting up a suitable supply network; processes in the warehouse

**Intended Learning Outcomes:**
After participating in this basic module, students are able to understand interrelationships between various planning problems in production and logistics. Analyze selected planning problems of the strategic, tactical and operational level (for details see learning content) and apply potential solutions to manage them. In doing so, the students know essential management tasks in production and logistics planning and learn to evaluate the economic and sustainability-relevant significance of production and logistics-related decisions (e.g. the trade-off between inventory and setup costs or between costs, service and environmental protection).

**Teaching and Learning Methods:**
The learning methods include lectures, tutorials and in-depth literature. The lectures serve to teach theoretical basics including the completion of exercises. The tutorials accompanying the lectures deepen the contents of the lectures in smaller groups and include calculation of exercises mainly in individual work, partly also in group work. Literature for in-depth study will be announced and recommended in the lecture.

**Media:**
Presentations, Script

**Reading List:**
Günther, H.O., Tempelmeier, H. (2020), Supply Chain Analytics
Ghiani, G., Laporte, G., Musmanno R. (2013), Introduction to Logistics Systems Management, 2. Aufl., Wiley

**Responsible for Module:**
Prof. Alexander Hübner

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

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

# Module Description

## CS0071: Material Flow Analysis and Life Cycle Assessment | Material Flow Analysis and Life Cycle Assessment [MFA&LCA]

Version of module description: Gültig ab summerterm 2024

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

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

**Description of Examination Method:**
Large courses of approx. more than 60 students: Written exam (90 minutes):
Students have to solve basic problems from the MFA, and LCA field. They have to demonstrate that they can analyze systems from a system and life cycle perspective. They have to prove their ability to use the correct terminology. In particular, they need to prove their ability to analyze and model material and energy flows, to determine and apply data, to assess environmental impacts, and to consider uncertainties. In addition they have to demonstrate their ability to interpret MFA and LCA study results and discuss the importance and applicability of the methods in practice.
Learning aids: pocket calculator.

Small to medium sized courses with up to approx. 60 students:
The students demonstrate the above-mentioned capabilities through group work. In groups of 3-5 students they receive case-based problems of material flow analysis and/or life cycle assessment. They have to solve these using the competencies obtained in the course. The results have to be presented and discussed (ca. 20') as well as documented in a report (ca. 20 pages). The individual contributions in both, presentation and report have to be specified.

The form of examination will be announced in class and on the learning platform in the second lecture week of the semester at the latest.

Voluntarily, students have the opportunity to increase their grade by up to 0.3 through extra work in form of individual assignments (hand-in and or presentation). The students either have to discuss a case study or a scientific paper or solve a problem from the topical scope of the lecture. They have to summarize their results in a 10' presentation + discussion or a 2-3 page report. Full mark for the course is obatainable without this voluntary work.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
None

**Content:**
• Introduction to systems and life cycle thinking
• The four phases of life cycle assessment
o Goal and scope definition
o Life cycle inventory analysis (LCI)
o Life cycle impact assessment (LCIA)
o Interpretation
• Material flow analysis
o Method of material flow analysis
o Material flow networks
o Determination of mass flows and stocks
o Material flow modelling
• Software systems and databases for material flow analysis and life cycle assessment
• Uncertainties and their handling
• Current trends and developments in material flow analysis and life cycle assessment
• Case studies

**Intended Learning Outcomes:**
At the end of the module students
• define key terms of material flow analysis and life cycle assessment
• explain the concepts of material flow analysis, life cycle assessment and systems analysis regarding their procedures and their theoretical backgrounds
to understand how to apply material flow analysis and life cycle perspective to various contexts and systems in order to assess their environmental performance
• gather necessary information, to choose suitable methods, and to apply these for simple MFA and LCA studies
• carry out simple MFA and LCA calculations by investigating underlying resource and energy flows associated with processes
• interpret MFA and LCA study results
• discuss the importance and applicability of the methods in practice

**Teaching and Learning Methods:**
Format: lecture and exercises to introduce the content, to repeat and deepen the understanding as well as practice individually and in groups. Some tutorials will be carried out computer-based.

Teaching / learning methods:
• Media-assisted presentations
• Group work/case studies

• Individual tasks
• Reading
• Computer lab exercises using MFA and LCA software systems

**Media:**
Digital projector, board, flipchart, online contents, videos, case studies, computer lab

**Reading List:**
• Baccini, P. & Brunner, P.H. (2012): Metabolism of the Anthroposphere: Analysis, Evaluation, Design. MIT Press.
• Brunner, P.H. & Rechberger, H. (2016): Handbook of Material Flow Analysis: For Environmental, Resource, and Waste Engineers. CRC Press.
• Curran, M.A. (2015): Life Cycle Assessment Student Handbook, Scrivener Publishing.
• Fröhling, M.; Hiete, M. (2020): Sustainability and Life Cycle Assessment in Industrial Biotechnology. Springer, Cham.
• Guinée, J.B. (2002): Handbook on life cycle assessment: operational guide to the ISO standards. Kluwer, Dordrecht.
• Hauschild, M.Z. & Huijbregts, M.A.J. (2015): Life Cycle Impact Assessment (LCA Compendium - The Complete World of Life Cycle Assessment), Springer, Cham.
• Hauschild, M.; Rosenbaum, R.K.; Olsen, S.I. (2018): Life Cycle Assessment: Theory and Practice. Springer, Cham.
• Jolliet, O., Saade-Sbeih, M. (2015): Environmental Life Cycle Assessment. CRC Press.
• Klöpffer, W. & Grahl, B. (2014): Life Cycle Assessment (LCA), Wiley-VCH.

**Responsible for Module:**
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

## CS0192: Accounting | Accounting

Version of module description: Gültig ab winterterm 2023/24

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>120 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
The examination of the students success consists of a written exam (90 min). Both submodules are equally important. Students may use a non-programmable calculator and a Handelsgesetzbuch (HGB) without additional notes as helping material.
• In the exam related to financial accounting, students show that they are able to correctly conduct individual financial statements, understand consolidated financial statements and apply consolidation principles as well as understand and apply balance sheet policy and analysis. This is done by means of conducting consolidations, and by solving arithmetic problems as well as theoretical problems regarding financial statements.
• In the exam related to controlling, students show that they can apply different approaches to problem solving - based on the understanding of controlling. By means of exemplary objects from controlling the students demonstrate that they can interpret planning problems and connections between different problems and that they are able to interpret their results and apply the learnt instruments.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
None

**Content:**
The module on financial accounting gives an overview over basic financial accounting, focusing on regulations regarding commercial accounting in individual and consolidated financial statements. In the first part of the module, basic principles of financial accounting are introduced, dealing with general economic accounting and special financial accounting. In the second part, individual financial statements in terms of commercial law are explained and regulations for annual accounts and annual reports are discussed in detail. The third part deals with consolidated financial

statements and consolidation principles as well as corresponding postings in accounting. In the fourth part of the module, fundamentals of balance sheet policy and analysis are discussed.

The module on controlling introduces students to the basics and instruments of Controlling. It covers the following
topics:
(a) Description of controlling functions, tools of operative and strategic controlling
(b) Identification and application of key performance indicators
(c) Planning and monitoring: Operative, tactical and strategic planning and monitoring
(d) Case examples especially in business administration, environmental management and corporate social responsibility (CSR)

**Intended Learning Outcomes:**
The modul consists of two parts:
(1) Upon successful completion of the module on financial accounting, students are able to understand the construction of individual and consolidated financial statements and to apply the accounting regulations practically. They can read and draw up balance sheets. Students are also able to evaluate which enterprises have to put up consolidated financial statements and which subsidiaries have to be included. Furthermore, they can independently carry out different consolidations correctly.
(2) After participating in this introductory module on controlling, students will be able to remember and understand the basic concepts, tasks and conception of controlling systems and coordination systems, to analyze problems concerning the coordination of planning and control in management systems and to apply the newly acquired knowledge to solve these problems.

**Teaching and Learning Methods:**
The financial accounting module consists of a lecture and a corresponding exercise, which is integrated into the lecture. In the exercise the content of the lecture and its understanding is deepened and extended by exercises and case studies. The lectures content is conveyed by means of presentation, while in the tutorial parts students can practise how to apply theoretical concepts practically.

The controlling module consists of lectures, exercises and tutorials. During the lectures, the contents are delivered by presentations and discussions. The lectures are used to convey the theoretical. In the exercises, students apply the acquired knowledge in solving exercises and implementing case studies. Students deepen their understanding through working in small student groups as well as solving exercises on their own.

**Media:**
Presentations, text books, lecture notes, exercises, lecture notes

**Reading List:**
Buchholz, Rainer: Grundzüge des Jahresabschlusses nach HGB und IFRS, 7. Aufl., München 2011
Meyer, Klaus: Bilanzierung nach Handels- und Steuerrecht, 22. Auflage, Herne 201
Einführung in das Controlling, Weber/Schäffer, Schäffer-Poeschel, 13. Auflage;
Controlling, Horvàth, Vahlen Verlag, 13. Auflage;
Globales Life Cycle Controlling, Stibbe, Springer Gabler Verlag, 1. Auflage;
Corporate Social Responibility und wirtschaftliches Handeln, Bruton, Erich Schmidt Verlag, 1. Auflage

**Responsible for Module:**
Prof. Alexander Hübner Prof. Hubert Röder

**Courses (Type of course, Weekly hours per semester), Instructor:**
Financial Accounting (Vorlesung, 2 SWS)
David G

Controlling (Vorlesung) (Vorlesung, 2 SWS)
Röder H [L], Pokholkova M, Röder H
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0200: Strategic and International Management & Organizational Behavior | Strategic and International Management & Organizational Behavior

Version of module description: Gültig ab winterterm 2023/24

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>120 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
The examination is provided in the form of a written, graded written exam (120 min). The written exam consists of single-choice questions that test knowledge at different levels: Knowledge questions test recall and reproduction of learned concepts, e.g. by reproducing different change management models; Decision questions test the classification or interpretation of learned content, e.g. by contrasting and comparatively analyzing different strategies of internationally active companies; Application and scenario questions test whether students can apply the content learned in the lectures to practical problems and challenges, e.g. by developing proposed solutions in the context of a case description on the topic of conflict management. The overall grade will be determined through the performance in the written examination. Students are permitted to use a non-electronic dictionary (English - Native Language or English Thesaurus) during the exam. Beyond that, no aids such as lecture notes, personal notes, etc. are allowed. There will be mid-term evaluations that may be included in the exam grade by 0.3.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Basics in Management

**Content:**
In accordance with the learning outcomes formulated above, the most important theories and methods of industrial and organizational psychology as well as strategic and international management are covered. Basic approaches and models of industrial and organizational psychology are used to understand the behavior of individual organizational members, teams and entire organizations. In addition, as globalization increases, companies in almost all industries

and of all sizes are operating internationally and must incorporate this reality into their strategic considerations. Not only is knowledge of international management necessary in the management of companies operating across borders, but the international dimension must also be taken into account in individual business functions. Therefore, a special focus is placed on the international dimension of the concepts to be dealt with. In detail, the following aspects will be addressed and made theoretically and practically useful: basics of employee management; basics and characteristics of strategic and international management; framework conditions of strategic and international management; effects of individual personality traits and motivation in organizations; ethical and moral behavior in organizations; structures and processes in work teams; change management in national and international organizations; theories of international corporate activity; strategies of internationally active companies; international dimension of individual business management functions; organizational culture in national and international comparison.

**Intended Learning Outcomes:**
After successful participation in the module, students will be able to understand and explain key concepts of industrial and organizational psychology as well as strategic and international management. In addition, students will be able to apply the gained knowledge to practical challenges and problems. Students will be able to identify and analyze challenges and problems in the areas of employee motivation, teamwork, decision-making behavior and communication with a special focus on international companies. Ultimately, they will be able to identify and demonstrate practical solutions to conflict management, change management, ethical problems and challenges in strategic and international management by applying the theoretical concepts learned.

**Teaching and Learning Methods:**
In the interactive lectures, the most important concepts, approaches and theories as well as their empirical evidence are taught and critically discussed with the students. The theoretical and methodological lecture contents are illustrated by examples and case studies and applied to practical problems. In addition, students are encouraged to engage intensively with the content and transfer the theories and methods covered through the analysis of instructional videos as well as individual assignments and/or work in small groups. Finally, the (self-) study of literature is planned.

**Media:**
Presentations (slides as download)
Videos
if applicable, current international scientific literature (English)
if applicable, case studies

**Reading List:**
Cavusgil, S.T., Knight, G., Riesenberger, J. R. (2008), International Business: strategy, management, and the new realities
Hill, C.W.L. (2014), International business: Competing in the Global Marketplace
Landy, F.J., & Conte, J.M. (2013). Work in the 21st century. Hoboken, NJ: Wiley.
Wood, J. M. (2016). Organisational behavior: Core concepts and applications. Milton, Australia: Wiley

**Responsible for Module:**
Prof. Claudia Doblinger

**Courses (Type of course, Weekly hours per semester), Instructor:**
Strategic and International Management (Vorlesung, 2 SWS)
Doblinger C [L], Doblinger C, Krinner S

Organizational Behavior (WI001121) am Campus Straubing (Vorlesung, 2 SWS)
Goerg S [L], Benzinger D
For further information in this module, please click campus.tum.de or here.

# Module Description

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

Version of module description: Gültig ab winterterm 2023/24

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

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

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

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**

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

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

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

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

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

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

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

**Responsible for Module:**
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, Martello S

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

# Module Description

## CS0197: Sustainable Investment and Financial Management | Sustainable Investment and Financial Management

Version of module description: Gültig ab winterterm 2021/22

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

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

**Description of Examination Method:**
The grading is based on a written exam with a duration of 120 minutes. To test whether the students acquired the theoretical basics in financial analysis and investment planning, questions are asked, where they have to prove their understanding of the introduced concepts. By using a calculator, the students for example have to analyze investment projects, create the optimal capital structure of projects or firms, evaluate bonds, stocks, or sustainability of investments.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
None

**Content:**
The module will give students a broad understanding of the instruments to analyze and evaluate investment opportunities such as:
- Financial Statement Analysis (balance sheet analysis, analysis of profit and loss account, statement of affairs)
- Investment Analysis (net present value method, actuarial return)
- Capital Budgeting (determination of free cashflows, choosing between alternatives)
- Cost of Capital (equity costs, borrowing costs, capital costs)
- Capital Structure

Furthermore, the students will be introduced to sustainability concepts in financial management such as social responsible investing, developments in finance and sustainability and ESG (Environment, Social, Governance) criteria for investments.

**Intended Learning Outcomes:**
Upon completion of this module students will be able to: (1) to name and apply important measures of company performance, (2) to analyze and choose investment projects, (3) to create the optimal capital structure of projects and firms, (4) restate and employ concepts of financial mathematics and (5) to evaluate financial instruments. The students will be trained in these methods by applications to sustainable financial management and discuss e.g., green investments. The course will prepare participants to understand major drivers and constraints of transforming the financial system to a more sustainable one. Furthermore, it will familiarize participants with the business, regulatory and technical perspective of sustainable finance and will acquaint them to take an active part in the discussion around the topic.

**Teaching and Learning Methods:**
The module will combine several teaching methods.
- Weekly Lecture: Presentation of theoretical basics and applied examples, supported by slides. As a better learning effect is reached by a dynamic learning environment, the student can join in live surveys with onlineTED.
- Exercise available on several dates: Calculation of selected exercises from the set of exercises in small groups so the students can directly ask questions about the calculations.
- Set of exercises with applied examples for individual practising of exercises.

**Media:**
Presentations, exercises with solutions

**Reading List:**
Berk/DeMarzo (2020), Corporate Finance, 3rd. Edition, Pearson.
Schoenmaker, D (2020): Principles of Sustainable Finance
Thompson (2021): Principles and Practice of Green Finance: Making the Financial System Sustainable

**Responsible for Module:**
Prof. Alexander Hübner

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

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

# Module Description

## CS0198: Green Marketing and Innovation Management | Green Marketing and Innovation Management

Version of module description: Gültig ab winterterm 2021/22

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

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

**Description of Examination Method:**
The grading will be based on a written exam (120 min). By answering multiple choice questions students have to show that they have understood and can apply models and concepts related to markets aspects of innovation and to the organization of the innovation process. The questions also assess whether students remember and understand green marketing basics (including key terms, theories, frameworks, the use of marketing strategies and marketing mix instruments, and their interrelationship with core concepts in marketing). The questions may require calculations. Students may use a nonprogrammable calculator to do these calculations. Bonus points can be gained by participating in the optional course group work.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
None

**Content:**
Market aspects of innovation:
Innovation: Examples and particularities,
Innovation and the development of industries,
Sources of innovation,
Innovation strategy: Analysis of the market, technology and competition,
Acquisition of technology: Market, cooperation and networks

Organizing the innovation process:
The innovation process within the firm,
R&D, production and marketing,

Cooperation for innovation?
Motivation and incentive systems,
Promotors and champions,
Roles in the innovation process,
Opposition against innovation within the firm,
Integrating customers into the innovation process,
Measuring and controlling innovation.

Marketing Management:
Principles of marketing,
Marketing strategy and environment in green business environments,
Creating customer value, satisfaction, and loyalty in green markets,
Information management and market research,
Analyzing green consumer and business markets,
Competition and differentiation from competitors,
Segmenting, targeting, and positioning,
Creating and managing products and services, brand management,
Pricing,
Marketing communications,
Marketing channels,
Services

**Intended Learning Outcomes:**
At the end of the module, students will be able to (1) recognize and apply models and concepts related to the market aspects of innovation (e.g., modes of acquisition of technology) and to the organization of the innovation process (e.g., promotors and champions in the innovation process), (2) identify how they can be concretely used in companies and in the context of green innovation, (3) remember and understand the key terms used in green marketing, (4) explain common marketing theories and frameworks in this context, (5) describe and justify the use of both marketing strategies and marketing mix instruments, and (6) relate the strategies and use of instruments to core concepts in marketing, such as customer lifetime value, segmenting, targeting, and positioning, decision making styles, customerperceived value, satisfaction, and loyalty, as well as branding in the context of green marketing.

**Teaching and Learning Methods:**
The module consists of two lectures including one or two sessions held by guest speakers to refer to state of the art examples of green marketing and innovation. Students will be motivated to read the literature before and after each lecture and relate it to the content taught in class. Furthermore, they will be motivated to discuss the content in online forums that are made available to the students.

Learning activities: Literature research, (optional) group project

**Media:**
Lecture slides are available via Moodle. Presentation slides, online discussion forum

**Reading List:**
Afuah  Innovation Management. strategies, implementation, and profits
Dodgson, Gann, Salter  The Management of Technological Innovation (Chapter 4)
Teece  Profiting from Technological Innovation: Implications for integration, collaboration, licensing and public policy
Stamm  Structured Processes for Developing New Products
Hauschildt, Kirchmann  Teamwork for innovation  the ""troika"" of promotors
Kotler/Keller/Brady/Goldman/Hansen (2016): Marketing Management, 3nd European ed., Pearson: Harlow.
Kotler/Armstrong (2018): Principles of Marketing, 17th ed., Pearson: Harlow.
Homburg (2017): Marketingmanagement. Strategie – Instrumente – Umsetzung – Unternehmensführung, 6. Aufl., Gabler: Wiesbaden.

**Responsible for Module:**
Prof. Klaus Menrad

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

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

# Module Description

## CS0073: Circular Economy | Circular Economy [CEC]

Version of module description: Gültig ab summerterm 2024

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

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

**Description of Examination Method:**
Examination for course sizes of more than approx. 70 students:
Written exam (90 minutes): Students have to analyze, assess and discuss (simplified) circular economy concepts and legislative frameworks on a local, regional, national and global level, determine starting points for an optimization of these concepts and apply them to real-life use cases. Thereby, they have to take different points of view (environmental, product, (material flow) system, macroeconomic, business). In doing so, the students have to prove their ability to use the right vocabulary, and their knowledge on the motivation, and methods of circular economy.

Examination for course sizes of up to approx. 70 students:
The students demonstrate the above-mentioned capabilities through group work. In groups of 3-5 students they receive case-based problems of the CE. They have to solve these using the competencies obtained in the course. The results have to be presented and discussed (ca. 20') and documented in a report (ca. 20 pages). The individual contributions in both, presentation and report have to be specified.

The form of examination will be announced  in class and on the learning platform in the second lecture week of the semester at the latest.

Voluntarily, students have the opportunity to increase their grade by up to 0.3 through extra work in form of individual assignments (hand-in and or presentation). The students either have to discuss a case study or a scientific paper or solve a problem from the topical scope of the lecture. They have to summarize their results in a 10' presentation + discussion or a 2-3 page report. Full mark for the course is obatainable without this voluntary work.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**

**Content:**
The module covers the following topics:
• Introduction
• Circular Economy as a concept to approach sustainability needs
• History and policies related to the development of a circular economy
• Motivation for CE
• Design for Sustainability and Circularity
• Business model innovation for CE
• Closed-loop economic systems
• Sustainability Assessment of CE solutions
• Enablers and barriers, potentials and limits of CE
• Rebound effects
• Special topics and case studies

**Intended Learning Outcomes:**
Students explain the importance of the circular economy within the context of resource shortages, climate change and further sustainability challenges. They discuss and understand the central concepts of a circular economy against their historical background covering both, traditional waste management and recycling approaches as well as more recent holistic concepts. They asses and discuss CE from an environmental, product, material, and economic perspective. Based on these competences, they can develop action approaches to transfer these concepts from theory into practice. They link independently urgent environmental problems of our time with the concept of the circular economy and design solution approaches based on their results. Regarding value creation in a circular economy, the students identify business opportunities, develop and discuss new innovative business models. They apply these concepts to specific use cases, and assess their implications from different perspectives, considering potentials and limits, enablers and barriers.

**Teaching and Learning Methods:**
Format: lecture and exercises to introduce the content, to repeat and deepen the understanding as well as practice individually and in groups.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies / reading of scientific publications with presentation
- Individual assignments and presentation to consolidate/repeat the learned contents
- Dismantling and recycling exercises in the CE-lab
- Plenary discussions to reflect the lecture contents

**Media:**
Digital projector, board, flipchart, online contents, case studies, computer lab

**Reading List:**
Recommended reading:
• Ayres, Robert U. (2002): A handbook of industrial ecology
• Charter, Martin (2019): Designing for the circular economy, Routeledge
• De Angelis, Roberta (2018): Business Models in the Circular Economy: Concepts, Examples and Theory, Palgrave Macmillan
• Franco-García, María-Laura ; Carpio-Aguilar, Jorge Carlos ; Bressers, Hans: Towards Zero Waste: Circular Eocnomy Boost, Waste to Resources, Springer
• Larsson, Mats (2018): Circular Business Models: Developing a Sustainable Future
• Schaub, Georg; Turek, Thomas (2016): Energy Flows, Material Cycles and Global Development: a Process Engineering Approach to the Earth System, Springer
van Erwijk, S.; Stegemann, J. (2023): An Introduction to Waste Management and Circular Economy, UCL Press
• Webster, Ken (2017): The Circular Economy - A Wealth of Flows, Ellen MacArthur Foundation Publishing
• Wiesmeth, H. (2021): Implementing the Circular Economy for Sustainable Development, Elsevier
Further literature will be given in the course.

**Responsible for Module:**
Prof. Dr. 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

## CS0202: Empirical Research Methods | Empirical Research Methods

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
Grading is based on a 100% multipe-choice exam (120 minutes) with about 50-60 questions at the end of the lecture. The questions will be of different character and allow students to show that they have understood basic concepts of empirical research and that they can analyze and evaluate research design and research outputs on their empirical and conceptual accuracy

Extra credit (Mid term assignment)
Accompanying this class, you will be able to participate in two types of work to earn extra credit toward your grade. This means that completing this work is not mandatory, and full marks can be achieved without participating. The first assignment is a teamwork task and focuses on the comprehension of a chosen empricial paper on either a problem form the management or policy literature. Each student has to write a short summary (1-2 pages). The second assignment is an individual task and is about the systematic creation and processing of a data set. The workload for this task is on average about 4-6 hours. Both extra assignments help to improve class performance and can improve the final grade. Participating successfully in these assignments may improve the final grade by 0,3.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Mathematics, Statistics

**Content:**
This course aims to enable students to understand empirical research. The course explains how research works and how to identify sources that meet a certain level of academic rigor to be trustworthy. This is important as only trustworthy information should become a source of learning and a foundation of managerial or political decision making.

To reach this goal the course will cover the following topics:
• Research ethics
• Research question and their implications
• Paper reading, positioning, and contributions
• Correlation and causality
• Choosing a research design
• Qualitative research
• Quantitative analysys & quantitative research design
• Using existing scales and data
• Data preparation and descriptive statistics
• Advanced quants

**Intended Learning Outcomes:**
This module will give you an introduction to empirical research methods, including the higher aims of empirical research, the standards it needs to meet, and a set of methods that you can directly apply. By the end of the module, you will thus be able to understand the scientific proces. They will be able to evaluate whether a result or statement is robust and indeed trustworthy. In doing so, not only will they be able to more critically evaluate everyday information, but they will also be prepared to participate in the scientific process. Students improving their ability to read and understand academic work. This modile prepares for future research seminars or the final thesis.

Knowledge Objectives
After the module students will be able to:
• understand the nature of the scientific process
• explore different approaches toward solving (scientific) problems
• use and apply selected empirical research methods (e.g., for seminar of final theses)
• understand the structure and evaluate the quality of academic papers
• (in parts) create their own research projects

Skills Objectives
• improve diagnostic and analytical skills
• think creatively about how best to solve complex problems
• build up critical thinking as well as judgment and interpretation skills
• learn how to evaluate different strategic options
• work together efficiently and effectively in groups

Learning Objectives
At the end of this module, students will be able to demonstrate understanding, critical assessment and application of the following:
• assess (pseudo-)scientific work
• understand and evaluate potential approaches toward answering academic questions
• utilize tools and techniques of empirical research for their own future studies

**Teaching and Learning Methods:**
The module consists of lectures and excersises. The lecture is based on slides and blackboard utilizing additional interactive elements. In the exersice, which takes place in the computer pool, students work on their own with data and learn how to utilize different software packages. Students will be very involved in the excersises and deepen their understand of the topics covered in the lectures.

**Media:**
Powerpoint, Board, Videos, Flipchart, Debates

**Reading List:**
For each session, practice-sheets will be provided. These sheets will also contain information on reading materials that elaborate on what we cover in class. We recommend the following textbooks (on which we will also draw to some degree for the lecture):
• Singleton, R. A., Straits, B. C., & Straits M. M.1993 (or newer). Approaches to Social Research (≥2nd ed.). Oxford University Press. (Abbreviated “ASR” in preparation sheets)
• In German: Backhaus, K., Erichson, B., Plinke, W., & Weiber, R. 2010 (or newer). Multivariate Analyse¬methoden: Eine anwendungsorientierte Einführung (≥13th ed.). Berlin: Springer.
• Salkind, N.J. 2008 (or newer)). Statistics for people who think they hate statistics (≥ 3rd ed.). Thousand Oaks, CA: Sage.
• Hair, J. F., Jr., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. 2005 (or newer. Multivariate data analysis (≥6th ed.). Upper Saddle River, NJ: Prentice Hall.

**Responsible for Module:**
Prof. Sebastian Goerg

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

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

# Module Description

## CS0204: Project Studies | Project Studies

Version of module description: Gültig ab winterterm 2021/22

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>German/English | **Duration:**<br>one semester | **Frequency:**<br>winter/summer semester |
| **Credits:***<br>12 | **Total Hours:**<br>360 | **Self-study Hours:** | **Contact Hours:** |

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

**Description of Examination Method:**
The project study is a practical task which either a single student or a a team of 2-5 students work on. The students deal with a specific task of a company, agency or any other similar institution (including research projects at university chairs) and work out the state of the current research on the given issue and describe their own specific solution to the given task . Based on scientific knowledge and methodical skills, the students evolve the task. The project study is supported by a professor of the TUM Campus Straubing as well as representatives of the firm, agency, and instituion respectively. The students present the results of their study in a written term paper. Grading will especially take into account the overall working outcome of the project with respect to the initial problem set, the selection and application of the chosen methodology as well as the discussion of the main findings. In case of team work, each student’s individual contribution to the written paper and the project's success must be identifiable and assessable.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
Basic knowlege in Business Administration and Economics

**Content:**
In the project study, students acquire hands-on experience by working with companies/institutions/ agencies on a particular assignment, for example:
- sustainability analyses of single activities or projects
- the application of optimization tools for problems out of the logistic sector,
- the description of a marketing strategy.
They structure the project and employ their methods and theories to develop results of practical value for the company/institution/agency. The project is supervised jointly by mentors from the

respective partner company/agency and the professor of the TUM Campus Straubing. The project study should be accomplished in about three to six months.

**Intended Learning Outcomes:**
After successfully completing the module students are able to work on a project in a systematic and academic manner. In case of team work, students can contribute a significant part to the work output of their team. They accomplish their task within a given time-frame. The students can identify and express problem sets. Furthermore they can term appropriate methodologies for problem solving and transfer them to a proper solution. Finally they can choose and apply the appropriate methodologies to solve the given problem.

**Teaching and Learning Methods:**
Working on a solution for the given project in a team or individually encourages students to deal soundly with a practical issue. Thus, they can apply their knowledge gained in their study on real issues firms struggle with. Further, they are able both to communicate the evolvment of the project and to present the solution to the supervisors from the company/institution and the university.

**Media:**
literature, presentations

**Reading List:**
Relevant literature will be selected and communicated specifically for the project.

**Responsible for Module:**
Prof. Alexander Hübner

**Courses (Type of course, Weekly hours per semester), Instructor:**
Projektstudium | project studies (Orientierungsveranstaltung, 1 SWS)
Hübner A [L], Hübner A, Lex E
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0195: Applications in Sustainable Management and Technology | Applications in Sustainable Management and Technology [Applic. in SMT]

Version of module description: Gültig ab winterterm 2021/22

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

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

**Description of Examination Method:**
The students work together in teams and deal with a specific question from practice. For this purpose, the students explain the current state of science and describe the specifics of their own research work. They also formulate the procedure for dealing with their practical problem and outline the solution steps. The results are documented in a written project work.

**Repeat Examination:**

**(Recommended) Prerequisites:**
None

**Content:**
The course conveys skills to develop solutions to specific problems in real business in case studies in the area of sustainability and enterprise planning. These relate to topics such as performance evaluation of supply chains, controlling, human resource or other functions.

**Intended Learning Outcomes:**
At the end of the module, students are able to understand basic and advanced problems of sustainable management and technologies. The intended learning outcomes of this course are to be able (1) to obtain insights from practice,
(2) understand the motivation and barriers of sustainability within a business context, (3) learn to assess appropriate approaches to solve a sustainability issue in practice and (4) to communicate and discuss solutions in spoken and written language.

**Teaching and Learning Methods:**
The course combines different learning methods: (1) presentations by the instructor and practioneers to brush up and deepen the participants' knowledge on sustainable management and technologies; (2) papers and presentations by the participants to document and communicate the problem and their solution; (3) coaching for the participants by experienced researchers to convey methodological skills to them; (4) written reports on peers' papers to develop the particpants' coummunication skills and for critical reflection.

**Media:**
Current literature, lectures, presentations

**Reading List:**
Petra Molthan-Hill (2017), The Business Student's Guide to Sustainable Management: Principles and Practice (The Principles for Responsible Management Education Series)

**Responsible for Module:**
Prof. Alexander Hübner

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

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

# Module Description

## CS0081: Modelling and Optimization | Modelling and Optimization

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
The examination is based on an exam (50% of evaluation) and a project work (50% of evaluation).

The 45min written exam tests the understanding of the modeling techniques discussed in the course. In the exam students have to answer questions, apply algorithms to solve problems, create mathematical models for small example problems, and discuss presented results. By this the students have to demonstrate that they have understood and can apply the mathematical models and methods to solve business planning problems.

The project paper serves the assessment of the understanding of the modeling language. For the project paper the participants get a randomly assigned fictive, extensive decision problem. For this problem, the following has to be prepared:
- a modeling of the problem as a mathematical program, as well as explanation of the program
- an implementation of the program in OPL
- a verbal and graphical explanation of the of the results for the original problem

The grading of the project paper is done by the following criteria:
- Correctness of modeling and implementation as well as of the results (60% of examination)
- Clarity, comprehensibility and efficiency of the implementation (30% of evaluation)
- correct language, typesetting and outer form of the paper (10% of evaluation)

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Management Science

**Content:**
This course is about modeling, solving and analyzing planning and decision problems using mathematial concepts. The concepts are used across different industries, departments and organizations. The lecture will treat the Management Science approach to decision making in general and the following topics in particular: Basics of linear optimization, introduction to optimzation and corresponding languages (e.g., OPL), techniques of binary modeling, optimization of graph problems, problems with multiple objective functions, basic techniques of stochastic optimization and interfaces to other applications.

**Intended Learning Outcomes:**
After successful completion of the module students are capable of modelling planning problems. Students learn to model real life business problems e.g. from production and logistics by applying mathematical programming techniques. They can independently implement mathematical models by using an optimization language (e.g., OPL) on a PC and they are able to solve the models in Optimization Studio and interpret the results. Furthermore, they deepen their knowledge in several different modeling techniques.

**Teaching and Learning Methods:**
The module consists of a lecture and exercise courses, which are provided weekly. In the lecture the content is jointly developed with the students mainly by using slides. The exercise course repeats parts of the lecture contents by using examples and offering the opportunitis to program poblems individually. The excercises give the student the opportunity to pose questions and receive immediately help from the teaching assistant.

**Media:**
Script, Presentation slides

**Reading List:**
Kallrath, Josef and John M. Wilson: Business Business optimisation using mathematical programming. Macmillan, Basingstoke, 1997
Popp, Andreas: Modellierung und Optimierung mit OPL. epubli, 2015
Taha, Hamdy A.: Operations Research: an introduction. 8th ed., Pearson Prentice Hall, Upper Saddle River (NJ), 2007

**Responsible for Module:**
Prof. Alexander Hübner

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

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

# Module Description

## CS0203: Communication Skills | Communication Skills

Version of module description: Gültig ab winterterm 2021/22

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

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

**Description of Examination Method:**
Students can choose between a number of courses addressing different communicative challenges. The examination is not graded (Studienleistung) and can be an oral assessment or a written exam. Please find detailed information regarding course examinations, content, learning outcomes, literature and teaching and learning methods in the individual course description (Lehrveranstaltungsbeschreibung) in TUMonline.

For example:
The oral assessment or presentation assess students' ability to transport their point of view in a comprehensible and well-structured manner. Students show that they can communicate scientific or business issues in a careful but effective way. They communicatively create a situation of mutuality independent of culture-specific particularities. Answering questions students show that they can advocate their angle on a topic using communication methods.

A list of up-to-date information in which courses students may earn credits will be provided by the program management (Studienkoordination) at the beginning of the semester.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**

**Content:**
Students can choose between a number of courses addressing different communicative challenges:

(1) Presentation & Moderation Techniques:

- use and effect of voice, language and body language
- managing the impact on employees and customers
- defining explicit goals and objectives
- responsibilities, role and self-perception of an facilitator
- strategies how to conduct a fruitful discussion

(2) Conflict Management & Conduct of Negotiations
- conflict types
- causes and development of conflicts
- systematic conflict analysis (e.g. stages of escalation after Glasl)
- conflict patterns
- concepts of negotiation strategies,
- conflict de-escalation

(3) Business Plan
- developing a business plan
- assessment of business ideas
- analyzing market & competition
- pitching business idea

(4) Intercultural Communication
- share information across different cultures and social groups
- interact with people from other cultures
- understand customs from people of different countries

(5) Language Courses
(offered by TUM Language Center or courses completed abroad equivalent to 3 ECTS)
- learn a foreign language
- be more open to another culture
- assessment of business ideas; analysing market & competition

**Intended Learning Outcomes:**
Upon successful completion of the module students are able to (1) efficiently and appropriately communicate business and scientific topics to others such as employees or an audience. (2) They are able to present and discuss complex issues referring to a scientific basis within groups or in front of an audience and (3) lead a discussion. Furthermore, they are able to (4) tackle conflict situations and (5) manage to communicatively find a solution.

**Teaching and Learning Methods:**
To sharpen their communication skills the focus in these courses is to practice in different situations and settings. Depending on the selected course, students will e.g. hold short presentations, pitches or exercise in role-plays. To deepen and strengthen these learning experiences peers and instructors will give immediate feedback.

**Media:**
PowerPoint slides, moodle, videos, online learning materials

**Reading List:**
- Ant, Marc; Nimmerfroh, Maria Christina; Reinhard, Christina (2014); Effiziente Kommunikation - Theorie und Praxis am Beispiel “Die 12 Geschworenen”; Springer Gabler
- Alan Barker (2013); Improve Your Communication Skills; Kogan Page Publishers

**Responsible for Module:**
Prof. Alexander Hübner

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

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

# Module Description

## WI001119: Business Law | Business Law [BusLaw]

Version of module description: Gültig ab summerterm 2022

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>120 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
In the final assessment students will need to demonstrate to what extent they have met the Learning Objectives. This assessment will be held as a written exam of 120 minutes in which students are allowed to use the applicable statutory law. The exam consists of two parts which count for approximately 50 per cent each .
In the first part, students will be asked theoretical questions. This will demonstrate to what extent they have memorised and understood principles of the law of contracts (formation, discharge, and liability), torts, and company law under German, European and Common Law. Students will also be asked to apply their knowledge to known and fictional cases. This second part demonstrates if students have developed the required legal analytical skills. Students also need to demonstrate their ability to apply their knowledge to fact settings not discussed in the lecture, and to evaluate the legal consequences.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**

**Content:**
This module covers the legal essentials of running a business. It includes an overview of the legal framework in Germany and Europe, the formation and termination of contracts, selected types of contract (in particular, sale of goods), torts, property law, and company law. The module covers aspects of the German legal framework as well as the common law. It cannot be replaced with "Wirtschaftsprivatrecht 1".

**Intended Learning Outcomes:**
At the end of this module students will be able

(1.) to name and understand the rules and principles of both German business law and the common law which are most important for businesses,
(2.) to grasp and apply the legal principles regulating business activity, in particular regarding liability under tort, contract and company law;
(3.) to analyse legal implications of typical business situations and to identify their options;
(4.) to present the results of their analysis in a written analysis.

**Teaching and Learning Methods:**
The lecture will cover the theoretical aspects of the module in a discussion with the lecturer. The tutorial will focus on case studies. It will provide the opportunity to work individually or in groups on case scenarios (known and unknown), covering various issues of German and the common law. The purpose is to repeat and to intensify the content discussed in the lecture and to review and evaluate legal issues from different areas of law in everyday situations. Students will develop the ability to present these findings in a concise and well-structured written analysis.

**Media:**
Reader, Presentations (PPT), Cases

**Reading List:**
Robbers, An Introduction to German Law (6th ed., 2017)

**Responsible for Module:**
Maume, Philipp; Prof. Dr.

**Courses (Type of course, Weekly hours per semester), Instructor:**
Business Law 1 (WI001119, englisch) am Campus Straubing (Vorlesung, 2 SWS)
Geigenberger S, Reiner M

Business Law 1 (WI001119, englisch) am Campus Straubing - Exercise (Übung, 2 SWS)
Geigenberger S, Reiner M
For further information in this module, please click campus.tum.de or here.

# Elective Modules | Elective Modules

# Electives in Management and Technology | Electives in Management and Technology

## Module Description

# CS0005: Introduction to Development Economics | Introduction to Development Economics

Version of module description: Gültig ab winterterm 2024/25

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>120 | **Contact Hours:**<br>60 |

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

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

**Repeat Examination:**
End of Semester

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

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

course provides the theoretical basis and empirical evidence for the analysis of such questions against the background of current development policy issues.

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

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

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

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

**Responsible for Module:**
Prof. Anja Faße a.fasse@tum.de

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

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

# Module Description

## CS0027: Behavioral Economics | Behavioral Economics

Version of module description: Gültig ab winterterm 2023/24

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>120 | **Contact Hours:**<br>60 |

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

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

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
VWL/Economics

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

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

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

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

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

**Responsible for Module:**
Prof. Sebastian Goerg

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

# Module Description

## CS0061: Seminar in Behavioral Economics | Seminar in Behavioral Economics

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
The learning results are tested in form of a written thesis. The students write a theoretical and/ or empirical thesis of a maximum of 15 pages that addresses a current research problem in the area of behavioral economics. They prove that they have understood the content of the current academic literature and are able to understand the required empirical analyses.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Behavioral Economics

**Content:**
After being introduced to adequate research designs in the area of beahvioral economics, students explore the academic literature on a choosen topic. The topics are typically related to human behavior in an economic context and potential behavioral interventions for more sustainable behavior.
Potential topics are:
-Green Nudges
-Social Comparison
-Choice Architecture

**Intended Learning Outcomes:**
After sucessful completion of the module the students are able to derive a current academic research questions and to respond to it by using the relevant literature in the area of Behavioral Economics. In addition to the required literature analysis based on peer-reviewed academic

journals, the students are able to interpret the relevant empirical analyses, to critically review studies, and to identify the potential relationship of different strands of research.

**Teaching and Learning Methods:**
The students will be familiarized with the basics to conduct literature reviews in the area of Behavioral Economics. Students work on a reasearch question and learn to summarize the current state of research. Thereby students learn how to critically review current research results and research designs. The students apply these contents to their own research questions in the thesis. The students present their results in front of the other seminar members, and discuss their results with the group.
The students have to write a seminar thesis in order to learn how to write an academic paper based on a relevant research questions.

**Media:**
Presentation, Power-Point Slides

**Reading List:**
Relevant research articles are provided

**Responsible for Module:**
Prof. Sebastian Goerg

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

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

# Module Description

## CS0064: Environmental Management | Environmental Management [EM]

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
Written exam (90 minutes): By solving problems from the thematic field of the module students have to prove their understanding of the basics of corporate environmental management, their ability to apply environmental management methods in the field. In the solution of the problems they need to demonstrate their ability to identify and analyse environmental impacts of corporate activities, to apply the managerial toolset provided by the ISO 140000 series and the Environmental Management and Audit Scheme (EMAS) to (simplified) practical problems. In addition, they need to show that they are able to describe the application of these methods in practice based on case examples. Learning aids: pocket calculator.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**

**Content:**
The module contains units covering the following topics:
- Environmental impacts of industrial and business activities,
- Societal, economic and legal frameworks of environmental protection,
- Motivation for businesses for applying environmental management approaches and methods,
- Environmental Management Systems (e.g. ISO 14000 series, EMAS),
- Methods and tools for environmental management (indicators, reporting, life cycle assessment), and
- Recent and emerging topics in environmental management.

**Intended Learning Outcomes:**
Students understand basics of corporate environmental management and its relevance for companies, application potentials and their implementation. The discuss these in context of business and research, reflect it critically and derive consequences for companies and research.

**Teaching and Learning Methods:**
Format: Lecture with tutorial to introduce, train and deepen the contents of the module.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individulal assignments and presentation
The teaching and learning methods are combinded specifically for the treated topics. Typically, a thematic impulse or overview is given with a media-assisted presentation. Individual or group work assignments provide the possibility to apply the acquired competencies, to repeat and deepen these as well as to prepare the transfer to other fields.

**Media:**
Digital projector, board, flipchart, online contents, case studies

**Reading List:**
Recommended reading:
- Theodore (2017): Environmental management, Chapman and Hall/CRC.
- Antweiler (2014): Elements of environmental management, Univ. of Toronto Press.
- Belchem (2014): Manual of Environmental Management, Taylor and Francis.
- Amilleri (2017): Corporate sustainability, social responsibility and environmental management, Springer.
- Mitchell (2002): Resource and environmental management, Prentice Hall.
- Mulvihill and Harris (2017): Environmental management: critical thinking and emerging practices, Taylor and Francis.

**Responsible for Module:**
Prof. Hubert Röder

**Courses (Type of course, Weekly hours per semester), Instructor:**
Environmental Management (Exercise) (Übung, 2 SWS)
Röder H [L], Röder H

Environmental Management (Lecture) (Vorlesung, 2 SWS)
Röder H [L], Röder H
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0068: Intermediate Microeconomics | Intermediate Microeconomics [Micro II]

Version of module description: Gültig ab winterterm 2023/24

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>120 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
In the exam (written, 120 minutes) students should demonstrate their ability to adequately interpret advanced microeconomic concepts and apply the methods worked on in class. By means of multiple-choice-questions, which are either embedded in a context/case/scenario or require prior computation, students' capacity to apply the learned solution strategies to new settings and draw correct economic implications is assessed. They show their ability to assess and evaluate decisions under uncertainty and asymmetric information as well as strategic interaction of decision makers. Hereby, students demonstrate their capacity for abstraction (thinking in economic models) and concretization (interpreting and applying the results of the model). A non-programmable calculator is allowed.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Microeconomics

**Content:**
The module imparts advanced concepts and methods of microeconomics, focussing on choice under uncertainty and strategic interaction. It examines markets under asymmetric information and imperfect competition.

Covered topics include Expected Utility Theory, Adverse Selection, Moral Hazard, Game Theory, and Strategic Interaction in Oligopolistic Markets.

These topics will be linked to current issues of climate policy and sustainability.

**Intended Learning Outcomes:**
After attending this module participants will be able to describe and evaluate decisions under uncertainty and/or asymmetric information. They will be capable of analyzing the functioning of competitive markets and assessing market failure arising from asymmetric information. They understand incentives and can solve problems of incentive compatibility. They know the fundamentals of game theory and are capable of analyzing strategic interaction like social dilemmas and coordination problems. Based on economic theory students can provide policy advice und evaluate concrete policy measures.

**Teaching and Learning Methods:**
An interactive lecture introduces advanced microeconomic concepts and theories and illustrates them with the help of topical empirical examples. Classroom experiments complement the classic bird-eye's perspective by nudging students to put themselves in the positition of particular economic players, thereby requiring them to actively reflect the concepts introduced. Online surveys at the end of each chapter enable students to select which topics they would like to intensify in subsequent classes. In the accompaying exercise class, students practice, on specific problems and examples, the mathematical techniques needed to develop a deeper understanding of the economic concepts. In self-study students use the textbook to repeat the concepts introduced in class and apply them to additional examples.

**Media:**
Text books, script, exercises, online polls, videos

**Reading List:**
- Gravelle, Hugh und Ray Rees (2004): Microeconomics, Pearson
- Jehle, Geoffrey und Philip Reny (2011): Advanced Microeconomic Theory, Pearson
- Kreps, David (1990): A Course in Microeconomic Theory, Princeton University Press
- Osborne, Martin (2004): An Introduction to Game Theory, Oxford University Press
- Shy, Oz (1996): Industrial Organization: Theory and Applications, MIT Press

**Responsible for Module:**
Prof. Sebastian Goerg

**Courses (Type of course, Weekly hours per semester), Instructor:**
Intermediate Microeconomics (Exercise) (Vorlesung, 2 SWS)
Goerg S [L], Sakakibara A

Intermediate Microeconomics (Lecture) (Vorlesung, 2 SWS)
Goerg S [L], Sakakibara A
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0072: Policy and Innovation | Policy and Innovation

Version of module description: Gültig ab winterterm 2023/24

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>summer semester |
| **Credits:***<br>5 | **Total Hours:**<br>150 | **Self-study Hours:**<br>90 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
The grading is based on a written exam (90 Minutes). The written form of the exam allows a comprehensive assessment of students' knowledge and understanding of the basic principles of policy and innovation. They will answer questions about the concepts explaining the strategies and options that policymakers and firms have in order to promote the usage of renewable resources. They will also answer questions about policy effects on the innovation activities of different actors and evaluate the implications for technology development and diffusion.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Entrepreneurship, Introduction to Innovation Management

**Content:**
The module introduces students into basic principles of the topic of policy and innovation from a global and international perspective. Students will be equiped with basic knowledge on:
- definitions about policy and innovation
- assessment of politcal incentives, especially related to climate change and renewable resources
- relation to sustainability, networks, ecosystems and social innovation.

Beyond that, students will engage in break-out group workshops to personally experience the process of developing business models in the context of climate change / renewable resources. Students give presentations to the audience and discuss their results.

**Intended Learning Outcomes:**
Following the completion of the course, the students will be familiarized with theoretical concepts and empirical methods to:

- assess policy effects on the innovation activities of different actors and evaluate the implications for technology development and diffusion
- identify and evaluate business opportunities and design business concepts/plans in the context of renewable resources / climate change
- understand institutional and technological barriers that affect large-scale system transformations and be able to develop scenarios for policy and firms to meet environmental and societal goals

**Teaching and Learning Methods:**
The module will combine several learning methods.
- The basic knowledge as well as real world examples and case studies will be provided through the lecture.
- Discussions in the lecture and active participation are encouraged and will contribute to deepen the understanding of the concepts introduced.
- In the tutorial, the academic concepts will be discussed and applied in case studies. The students will further apply (part of) their theoretical knowledge to real-world problems and present their results in teams. This format fosters team work.
- Students will get additional background knowledge from the scientific literature in private reading.

**Media:**
Presentation, Power-Point Slides, Case Studies

**Reading List:**
Fagerberg, J.; Mowery, D.C.; Nelson, R.R. (eds.), 2005: The Oxford Handbook of Innovation. Oxford University Press, Oxford.

**Responsible for Module:**
Claudia Doblinger claudia.doblinger@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

## CS0080: Case Study Seminar in Supply Chain Management | Case Study Seminar in Supply Chain Management

Version of module description: Gültig ab summerterm 2022

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|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>120 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
The students work together in teams and deal with a specific question from practice. For this purpose, the students explain the current state of science and describe the specifics of their own research work. They also formulate the procedure for dealing with their practical problem and outline the solution steps. The results are documented in a written project work (75% of evaluation) and a final 30 minutes presentation (25% of evaluation).

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
Successful complition of courses in Management Science and Sustainable Operations

**Content:**
The course conveys skills to develop solutions to specific problems in real business in case studies in the area of supply chain management. These relate to topics such as performance evaluation of supply chains, optimization of transport- and warehousing processes, inventory management, production processes and its planning.

**Intended Learning Outcomes:**
At the end of the module, students are able to structure, think through and develop solutions on their own. The intended learning outcomes of this course are to be able (1) to apply knowledge and skills from prior courses in supply chain management to a specific problem from real business (case study); (2) to structure a problem and its causes; (3) to assess appropriate approaches to solve the problem; (4) to develop an appropriate solution to the problem; (5) to communicate and discuss solutions in spoken and written language.

**Teaching and Learning Methods:**
The course combines different learning methods: (1) presentations by the instructor to brush up and deepen the participants' knowledge on supply chain management and convey approaches to solve case studies; (2) papers and presentations by the participants to document and communicate the problem and their solution; (3) coaching for the participants by experienced researchers to convey methodological skills to them; (4) written reports on peers' papers to develop the particpants' coummunication skills and for critical reflection.

**Media:**
Current literature, lectures, presentations

**Reading List:**
Günther, H.O., Tempelmeier, H. (2020), Supply Chain Analytics
Ghiani, G., Laporte, G., Musmanno R. (2013), Introduction to Logistics Systems Management, 2. Aufl., Wiley

**Responsible for Module:**
Prof. Alexander Hübner

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

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

# Module Description

## CS0082: Supply Chain Simulation | Supply Chain Simulation

Version of module description: Gültig ab winterterm 2023/24

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|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>German/English | **Duration:**<br>one semester | **Frequency:**<br>summer semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>120 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
Because of the mediation of competences and the interactive character of the module using the supply chain simulation „The Fresh Connection“ several group presentations are part of the evaluation:
- Introductory presentation for a supply chain topic (30 minutes / 50% of the evaluation)
- Short presentation concerning decision alternatives within a round of the simulation (10 minutes / 20% of the evaluation)
- Presentations of the decisions made within the respective rounds of the simulation, the lessons learnt and the results (15 minutes / 30% of the evaluation)

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Operations Research

**Content:**
The module is an innovative combination of mediation of theoretical background knowledge, practice and experience using the supply chain simulation „The Fresh Connection“. The topics in detail:
- Basics and decision making in supply chain management
- Supplier Management
- Demand Management
- Capacity and Production Management
- Inventory Management and Planning
- Supply Chain Mapping and component characteristics
- Supply Chain Strategy
- Variables and KPI‘s on strategic and tactical level

- External Collaboration

**Intended Learning Outcomes:**
The students will obtain a practice oriented overview of basics, decisions and interrelations in supply chain management. The students will achieve the ability to understand influencing factors and consequences of supply chain decisions with the help of the simulation “The Fresh Connection“. The students will achieve the competence for autonomous academic self study and application-oriented presentation of content. A focus of the mediation of competences is on work in cross-functional teams.

**Teaching and Learning Methods:**
Lecture, Web-based supply chain management simulation and learning environment, Self study and group work with presentation of result

**Media:**
Lecture, simulation software, presentations

**Reading List:**
Fisher, M.L. , What is the right supply chain for your product?, Harvard Business Review, March-April 1997
Christopher, M. , Logistics and Supply Chain Management, creating value-added networks, Prentice Hall, 2005
Chopra, S. and Meindl, Supply Chain Management, Pearson Education, third edition, 2007

**Responsible for Module:**
Prof. Alexander Hübner

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

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

# Module Description

## CS0127: Methods for Evidence Based Policy and Management | Methods for Evidence Based Policy and Management

Version of module description: Gültig ab summerterm 2022

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

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

**Description of Examination Method:**
Assessment will be based on a written report. With the report students will demonstrate that they understand policy evaluations and are able to summarize them effectively. In the report, students work with an academic policy paper, which they replicate, critically evaluate and summarize for an interested lay audience. They may choose from a list of papers discussed in class or they may write about a paper they choose themselves with prior approval from the lecturer.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
Microeconomics, Statistics, Empirical Research Methods

**Content:**
In this course students learn the fundamental skills of economic policy analysis.
Firstly, students will learn to evaluate the impacts of existing public policies (or natural experiments) by using two widely used econometric techniques, difference-in-difference (DiD) and regression discontinuity design (RDD). Secondly, students will learn about the role of experimental methods, such as randomized controlled trails, field experiments, and lab experiments, for the impact evaluation of economic policies.
The methods will be introduced based on research papers which cover areas of development economics, environmental economics, behavioural economics, labor economics, managerial economics, public economics, and political economics. For example, papers could cover diverse topics such as the impact of subsidies for renewable and low-carbon energy technologies or behavioural intervention like nudges to reduce energy consumption of private households.

**Intended Learning Outcomes:**
In this module, students will develop the ability to empirically evaluate the economic consequences of interventions and policies. At the end of the module, have a good understanding on common policy analysis tools and be able to compare the merits and disadvantages of different policies or interventions. They will be able to estimate the likely consequences of proposed policies. Students will understand the nature of scientific evidence and how to translate this into management and policy advice. They can explain and apply the econometric methods used for economic policy analysis. Students understand the challenges of evidence-based policy advice and are able to critically asses existing studies.

**Teaching and Learning Methods:**
The module consists of a lecture and an exercise.

The lecture is designed as an interactive frontal lesson (PowerPoint, blackboard), as a large number of policy evaluations will be discussed together with the applied methods. Thereby, the lecture will also revisit and combine topics and methods covered in previous modules, e.g. Microeconomics, Environmental Economics, and Empirical Methods. During the exercise, students will gather data, manage datasets, and analyse them with STATA. In particular, during each exercise, students will go through a research/policy paper, its publicly available data, and replicate its basic findings (many economic and scientific journals publish their datasets for replication purposes). In groups, students will write short policy reports summarizing the academic papers and their own replications.

The lecture and exercise are designed to introduce students to the methods of policy evaluations and how to apply them.

**Media:**
Presentations, slide scripts, computer,  statistic software (STATA)

**Reading List:**
Will be provided and is based on research and policy papers

**Responsible for Module:**
Prof. Andreas Pondorfer

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

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

# Module Description

## CS0158: Seminar in Innovation and Technology Management | Seminar in Innovation and Technology Management

Version of module description: Gültig ab summerterm 2024

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

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

**Description of Examination Method:**
The learning results are going to be proved in form of a written thesis. The students write a theoretical and/or empirical thesis that addresses a current research problem in the area of Innovation and Technology Management. For this, they create a written paper, which, depending on the topic, ranges between 15 and 20 pages. They prove that they have understood the content of the current academic literature and are able to conduct empirical analyses.

**Repeat Examination:**

**(Recommended) Prerequisites:**
Entrepreneurship, Introduction to Innovation Management

**Content:**
Current research questions from the area of Innovation and Technology Management, e.g., Ecosystems, sustainable innovation, digitization

**Intended Learning Outcomes:**
After sucessful completion of the module the students are able to derive a current academic research questions and to respond to it by using the relevant literature in the area of innovation and technology management. The research questions are typically related to the promotion of sustainable innovation or entrepreneurship within ecosystems. In addition to the required literature analysis based on peer-reviewed academic journals, the students are able to conduct and interpret relevant empirical analyses such as regressions.

**Teaching and Learning Methods:**
Teaching methods: The students will be familiarized with the basics to conduct literature reviews in the area of innovation and technology management and to conduct and interpret empirical analyses such as regressions using statistical programs like STATA. The students apply these contents to their own research questions in the thesis. The students present their results in front of the other seminar members, and discuss their results with the group.
The students have to write a seminar thesis in order to learn how to write an academic paper based on a relevant research questions in the area of innovation and technology management.

**Media:**
Presentation, Power-Point Slides, Case Studies

**Reading List:**
Relevant research papers will be provided

**Responsible for Module:**
Prof. Claudia Doblinger

**Courses (Type of course, Weekly hours per semester), Instructor:**
Seminar in Innovation and Technology Management (Seminar, 4 SWS)
Doblinger C [L], Mess C
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0240: Open Circular Innovation | Open Circular Innovation [OCI]

*Innovation Challenges from an Industry Perspective*

Version of module description: Gültig ab winterterm 2023/24

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|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>5 | **Total Hours:**<br>150 | **Self-study Hours:**<br>105 | **Contact Hours:**<br>45 |

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

**Description of Examination Method:**
Individual presentation: Students will prove their understanding of opportunities and challenges in the field of circular economy. They show that they are able to put themselves into the situation of a specific company and quickly identify their focal circular economy topics.

Group presentation and group discussion (systemic circular innovation): Students will prove their understanding of systemic circular economy correlations and their ability to develop a feasible cross-value-chain concept. They understand different stakeholder perspectives and develop a strong argumentation line in a specific stakeholder role.

Group presentation (consulting pitch): Students will prove their ability to identify the need for circular economy analyses in a specific company and to propose a suitable open circular innovation approach. They show their skills to present a convincing consulting pitch in a power point presentation.

The students will be evaluated based on the following assignments:
- Individual presentation of a circular economy analysis in a specific industry (~10 min., based on a structured argumentation line, individual contribution evaluated) (20%)
- Group discussion in a stakeholder role play: conducting negotiations for a circular system innovation from a specific stakeholder perspective (~30 min., individual contribution evaluated) (20%)
- Group presentation and Q&A for a jointly developed circular system innovation (~30-45 min., based on a prototype model, group contribution evaluated, group size: ~5) (30%)
- Group presentation and Q&A for a circular innovation consulting pitch (~20-30 min., based on a power point slide deck, group contribution evaluated incl. submitted power point deck, group size: ~3-5) (30%)

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
Students of this module should have passed the Bachelor Modules Circular Economy as well as Technology and Innovation Management.

**Content:**
The module contains units covering the following topics:
- Circular economy opportunities and challenges in different industries
- Circular economy strategy analysis
- Multiple lifecycle thinking
- Open circular innovation process
- Cross-value-chain circular systems
- Stakeholder negotiations
- Circular economy consulting pitch
- Industry deepdive for circular electronics
- Literature research and current trends/developments
- Case studies

**Intended Learning Outcomes:**
At the end of the module, the students are able to analyze strategic circular opportunities and challenges from a corporate perspective. They know different forms of open innovation and can evaluate their suitability for circular economy use cases in practice. Furthermore, they have gained an understanding of systemic correlations in a circular economy and can identify the conceptual circularity differences between industries.

The students know how to set up a cross-value-chain circular innovation approach and how to negotiate a circular solution from a specific stakeholder role. They are able to analyze circular opportunities from the perspective of a circular economy consultancy and can write and present a pitch for a circular innovation project.

The gained skills contribute to the students' ability to conduct strategic circular economy analyses in industry, set up open circular innovation processes, and approach systemic circular economy solutions in practice.

**Teaching and Learning Methods:**
The module Open Circular Innovation transfers the theoretical knowledge of the module Circular Economy to practice and reflects the concept from the perspective of different industries. Students are able to connect the fields of circular economy and innovation management in a new dimension and prove their knowledge in practice-oriented circular innovation challenges.

Teaching / learning methods:
- Lectures on circular economy and open innovation

- Case reflections
- Academic and web research
- Workshop with group work on a systemic circular innovation concept
- Group work to build a prototype model for the systemic circular innovation concept
- Role play negotiations in a fictitious stakeholder group
- Workshop with group work on a circular economy consulting pitch
- Power point presentation
- Final group presentations

**Media:**
Power point, flipchart, online contents, online survey, case studies, prototype modeling, presentations

**Reading List:**
• Bocken, N. M. P., de Pauw, I., Bakker, C. A., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering, 33(5), 308–320. https://doi.org/10.1080/21681015.2016.1172124
• Chesbrough, H. W. (2003). Open Innovation: The new imperative for creating and profiting from technology. Harvard Business School Press.
• Chesbrough, H. W. (2006). Open innovation: A new paradigm for understanding industrial innovation. In H. W. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), Open innovation: Researching a new paradigm (pp. 1–12). Oxford University Press.
• Eisenreich, A., Füller, J., Stuchtey, M., & Gimenez-Jimenez, D. (2022). Toward a circular value chain: Impact of the circular economy on a company's value chain processes. Journal of Cleaner Production, 378, 134375. https://doi.org/10.1016/j.jclepro.2022.134375
• Eisenreich, A., Füller, J., & Stuchtey, M. (2021). Open circular innovation: How companies can develop circular innovations in collaboration with stakeholders. Sustainability, 13(23), 13456. https://doi.org/10.3390/su132313456
• Eisenreich, A., & Füller, J. (2023). You can’t go circular alone – A stakeholder approach to circular innovation. Circular Economy, 1(1). https://doi.org/10.55845/HKKE5160
• Ellen MacArthur Foundation. (2013). Towards the circular economy: Economic and business rationale for an accelerated transition. https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an
• Ellen MacArthur Foundation. (2019). Artificial intelligence and the circular economy: AI as a tool to accelerate the transition. https://emf.thirdlight.com/file/24/GgC25OAGBvwdiFGgtzZGVXuZsz/Artificial%20intelligence%20and%20the%20circular%20economy.pdf
• Eapen, T. et al. (2023). How generative AI can augment human creativity. https://hbr.org/2023/07/how-generative-ai-can-augment-human-creativity
• Freeman, R. E., Harrison, J. S., & Zyglidopoulos, S. (2018). Stakeholder theory: Concepts and strategies. Cambridge University Press. https://doi.org/10.1017/9781108539500
• Govindan, K., & Hasanagic, M. (2018). A systematic review on drivers, barriers, and practices towards circular economy: A supply chain perspective. International Journal of Production Research, 56(1-2), 278–311. https://doi.org/10.1080/00207543.2017.1402141

• Füller, J., Hutter, K., & Faullant, R. (2011). Why co#creation experience matters? Creative experience and its impact on the quantity and quality of creative contributions. R&D Management, 41(3), 259–273. https://doi.org/10.1111/j.1467-9310.2011.00640.x

**Responsible for Module:**
Prof. Magnus Fröhling

**Courses (Type of course, Weekly hours per semester), Instructor:**
Open Circular Innovation (Lecture) (Vorlesung, 2 SWS)
Fröhling M [L], Eisenreich A

Seminar Open Circular Innovation (Seminar, 1 SWS)
Fröhling M [L], Eisenreich A, Fröhling M
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0246: Practical Research Experience | Practical Research Experience

Version of module description: Gültig ab winterterm 2021/22

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

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

**Description of Examination Method:**
Grading is based on a project work. The project work consists of a written project report. The student works on a specific problem set. The student runs through several project stages: problem definition, division of work/tasks, decision making processes, and realization. Throughout this process, the student shows that she/he can develop appropriate strategies to cope with the set of problems. She/he shows the ability able to compose the state of research. In addition she/he demonstrates the ability to develop their own specific approach for a solution based on scientific knowledge as well as methodical skills.
Grading will especially take into account the overall working outcome of the project with respect to the initial problem set, the selection and application of the chosen methodology as well as the analyses and discussion of the main findings. The project work is set up in a way which enables the identification and evaluation of each student's individual contribution to the project's success.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
Basic knowledge in Business Administration and Management
Management Science (CS0075)
Sustainable Operations (CS0196)
Case Study Seminar in SCM (CS0080)

**Content:**
The research study consists of a specific problem statement or challenge. This challenge may have a research related or practical character. The research project and its findings regarding the outlined problem set are based on students' academic knowledge gained through their Bachelor study programs. Examples of topics covered in the context of a include (non-exhaustive list) for

example analyzing potential sales volumes with data mining techniques, identifying potential optimization actions or applying algorithms for certain business problems.

**Intended Learning Outcomes:**
After successful participation in the module, students obtain basic knowledge to work on research projects in an academic manner. Students understand on how to complete a research project in particular in identification research gaps, developing research questions, selecting appropriate research methods and apply them to actual research problem. Students obtain capabilities to deepen and apply theoretical concepts to the identified problem set and apply analytical solution finding skills. Students become able to manage resources, and deadlines through timely submission of the enumerated tasks in stages throughout their research projects.

**Teaching and Learning Methods:**
The development of the solution of the research question encourages the students to deal soundly with an academic subject based on their previously acquired academic knowledge. The project may happen at the premises of a respective company/institution or from a remote location. Participants are able to communicate the evolvement of the project by composing a project report and preparing a presentation of their solutions to the supervisors. With regards to content the research study takes an approximate time of 12-14 weeks.

**Media:**
literature, presentations

**Reading List:**
Project Management Institute (2013): A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fifth Edition
Further literature based on the specific topic

**Responsible for Module:**
Prof. Alexander Hübner

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

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

# Module Description

## CS0248: Markets for Renewable Energies and Biobased Products | Märkte für erneuerbare Energien und biobasierte Produkte

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
The exam performance is effected by a written test. Through comprehension questions it is reviewed whether the students have understood principles of market development in the covered markets. The students answer questions regarding the development and current situation on the markets of renewable energies and biogenic products as well as the most important factors that influence this market development. The students prove that they have understood the interest and behaviour of actors being active on these markets by answering corresponding questions.
Exam duration: 90 minutes.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Basic know-how to the functioning of markets

**Content:**

A) Introduction and overview

B) Markets for renewable energies
- Regenerative electricity
- Regenerative heat /cooling
- Sustainable mobility
- Sector coupling

C) Markets for biobased products
- Chemical markets

- Building & Living
- Biomaterials
- Other markets (e.g. paper, cardboard, carton, natural cosmetics)

**Intended Learning Outcomes:**
After attending the module, students will be able to show the developments of markets for energy and biobased products and discuss market development. Students are familiar with the relevance, size, and important influencing factors on the renewable energy markets as well as markets for material use of biogenic resources. They are able to compare these markets, to capture important determinants of market development, and to identify the use of fossile and regenerative energies as well as the use of biomass for material applications in a macroeconomic and societal context thus developing strategies for future use.

**Teaching and Learning Methods:**
The lecture will be done using Powerpoint with specifically worked out presentation scripts. In addition, published studies and statistical data related to the development and situation on the targeted markets will be integrated into the lectures. Furthermore, current topics are discussed with students.

**Media:**
Slide presentation, Lecture recordings; Interactions using Moodle; selected journal articles; current topic-related news, videos

**Reading List:**
Quaschning, Volker (2020): Erneuerbare Energien und Klimaschutz: Hintergründe – Techniken und Planung – Ökonomie und Ökologie – Energiewende. 5. Auflage. Hanser Verlag: München.

FNR (2014): Marktanalyse Nachwachsender Rohstoffe. Schriftenreihe Nachwachsender Rohstoffe 34. Gülzow.

**Responsible for Module:**
Thomas Decker

**Courses (Type of course, Weekly hours per semester), Instructor:**
Märkte für erneuerbare Energien und biobasierte Produkte (Vorlesung, 4 SWS)
Menrad K [L], Decker T, Emberger-Klein A, Menrad K
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0296: Seminar in Environmental and Development Economics | Seminar in Environmental and Development Economics

Version of module description: Gültig ab summerterm 2024

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|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter/summer semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>90 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
The exam consists of a written seminar paper of a maximum of 15 pages. The students prepare an academic literature and/or practical paper and answer a current question in the field of environmental or development economics. They demonstrate that they have mastered the current literature for the question and, if necessary, can understand smaller empirical evaluations.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
Introduction to Development Economics, Introduction to Environmental Economics, Empirical Research Methods

**Content:**
After the basics of good research design in the field of environmental and development economics have been introduced and discussed and the structure of scientific papers has been worked out together, the students work on a chosen topic area. Topics mainly relate to economic context as well
Behavioral interventions for more sustainable behavior.
Possible topics are:
- Agriculture in developing countries - Entrepreneurship in developing countries
- Poverty and nutrition
- Environmental assessment

**Intended Learning Outcomes:**
After successfully completing the module, students can derive an academic research question and answer it based on a literature review in the field of environmental and development economics. In

addition to the literature work necessary to answer the research questions, they learn to interpret the necessary empirical analyses
Critically question the results of individual studies and recognize connections between different strands of research.

**Teaching and Learning Methods:**
In the seminar, the basic principles of academic literature work in the field of environmental and development economics are learned. Students deal with a research topic and summarize the current state of academic research on this topic. They learn to critically question current research results and designs and draw connections between individual studies. The students apply these on their own initiative to a question in their seminar paper. The students present the results of their seminar work to their fellow students and discuss them together in the group. By writing a seminar paper, students learn how to prepare and present a scientific paper on a relevant question.

**Media:**
Research papers; presentation slides

**Reading List:**
Valerie Matarese (2013). Using strategic, critical reading of research papers to teach scientific writing: the reading–research–writing continuum, Editor(s): Valerie Matarese (2013). In Chandos Information Professional Series, Supporting Research Writing, Chandos Publishing,Pages 73-89. https://doi.org/10.1016/B978-1-84334-666-1.50005-9.)

Yongyan Li, Margaret Cargill, Xin Gao, Xiaoqing Wang, Patrick O'Connor (2019). A scientist in interdisciplinary team-teaching in an English for Research Publication Purposes classroom: Beyond a “cameo role”,
Journal of English for Academic Purposes, Volume 40, Pages 129-140. https://doi.org/10.1016/j.jeap.2019.06.005.

Yongyan Li, John Flowerdew (2020). Teaching English for Research Publication Purposes (ERPP): A review of language teachers’ pedagogical initiatives, English for Specific Purposes, Volume 59, Pages 29-41. https://doi.org/10.1016/j.esp.2020.03.002.

**Responsible for Module:**
Prof. Anja Faße

**Courses (Type of course, Weekly hours per semester), Instructor:**
Seminar in Environmental and Development Economics (Seminar, 4 SWS)
Faße A [L], Faße A
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0304: Research Excursion Bachelor | Research Excursion Bachelor

*B-REX*

Version of module description: Gültig ab summerterm 2024

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

## MGT001393: Sustainability and Law | Sustainability and Law

Version of module description: Gültig ab summerterm 2023

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

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

**Description of Examination Method:**
In the final assessment students will need to demonstrate to what extent they have met the Learning Objectives. This assessment will be held as a written exam of 120 minutes in which students are allowed to use the applicable statutory law. The exam consists of two parts which count for approximately 50 per cent each.
In the first part, students will be asked theoretical questions. Students will also be asked to apply their knowledge to known and fictional cases. This second part demonstrates if students have developed the required legal analytical skills. Students also need to demonstrate their ability to apply their knowledge to fact settings not discussed in the literature and to evaluate the legal consequences.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
No specific prerequisites.

**Content:**
The module provides an overview on how the law accommodates sustainability.
The lecture is divided into three parts:

The first part covers the introduction of the concept of sustainability into the legal system and discusses whether sustainability can be considered as a general legal principle.

The second part elaborates on the integration of sustainability aspects into the sphere of public law. For that purpose, various fields of law related to the management of specific natural resources are being assessed in detail (environmental law, construction law, energy law).

The third part examines the relevance of sustainability issues between private entities, including the topics of climate litigation, sustainability within supply chains and corporate governance (ESG).

The lecture follows a case-based approach. Each unit supplements the theoretical part with case studies based on the relevant legal provisions.

**Intended Learning Outcomes:**
At the end of the class students will be able to:
1. understand how sustainability is integrated in the body of law,
2. grasp the legal framework of sustainability within various fields of private and public law,
3. identify and analyse specific legal instruments utilized to enhance / prevent sustainable development,
4. assess legal provisions with regard to their implications on sustainability

**Teaching and Learning Methods:**
The lecture will cover the theoretical aspects of the module in a discussion with the lecturer. It will provide the opportunity to work individually or in groups on case scenarios, covering issues of sustainability in various fields of law. The purpose is to repeat and to intensify the content discussed in the lecture and to review and evaluate legal issues. Students will develop the ability to present these findings in a concise and well-structured written analysis.

**Media:**
Reader, Presentations (PPT), Cases.

**Reading List:**
Kahl/Weller, Climate Change Litigation (1st ed., 2021)
Schlacke, Umweltrecht (8th ed., 2021)

**Responsible for Module:**
Ann, Christoph; Prof. Dr.

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

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

# Electives in Engineering and Natural Sciences | Electives in Engineering and Natural Sciences

## Module Description

## WZ1654: Forest Management and Inventory | Forstmanagement und Waldinventur

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
Exam achievement shall be done in the form of a written report. The students calculate the key performance indicators for forestal decisions and illustrate decision-making procedures and alternatives based on case studies. They show in the report that they are able to outline and explain forest management business processes. They demonstrate that they are able to answer problems on forest management and inventory in their own words. Exam achievement shall be completed by a presentation of the students for a specific and clearly defined topic. The report shall be weighted at a ratio of 30/70. Type of exam and exam duration: orally (20 minutes) or writing (60 minutes)

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Forestry and Wood WZ 1614, Knowledge about Forestal Processes, Crop Establishment and Timber Harvest, Forest Growth (Basics of Silviculture WZ 1607).

**Content:**
The module aims at imparting to students in-depth knowledge of forest management. For that purpose it is necessary to explain forest logistics. As well management requirement from forestry such as: Timber trade, wood evaluation and business organisation as a tool for reaching the objective, selection of tree types and risk management in view of rotation period, management objective and climate change, optimisation of biological production using the example of dominant tree species in Bavaria as well as sale of wood as a central process towards products, services

and corresponding sales markets. The module also aims at developing understanding of the most important principles, sustainable management of forests and forestry.
Besides knowledge for practical performance of inventories and use of equipment including commonly used measuring instruments (cruising rod, altimeter, Vertex, Suunto) shall be imparted. Finally inventories are part of the lecture including complete enumeration as well as characterisation of forest resources.

**Intended Learning Outcomes:**
After attending the module the student will be able to use contents of forest management. He will be able to understand management processes in a forest company and implement principles to determine wood sorting and marketing in view of rotation period and management objective for a forest company.
It is possible for him to take selection decisions in a logical and transparent way by including economic and ecological criteria and thus understand central management processes in a forest company. The conflict of forest and game shall be understood concerning its impacts relevant for forest management. The students understand the use of measuring instruments for forest management and harvest planning. They are able to compare assessment of wood production of forest resources for different variants of timber harvest and implement it in practice.

**Teaching and Learning Methods:**
Project work using case studies in cooperation with a regional forest enterprise and AELF, practice by teamwork in the forest, presentation

**Media:**
Expert lecture, powerpoint, exercise sheets, measuring instruments

**Reading List:**
T. Knoke, Forstbetriebsplanung (Forest Operational Planning), 2012, 408 pages, 125 black-and white illustrations, Dimensions: 17,7 x 23,7 cm, Paperback (TB), German
Hrsg. v. Thomas Knoke ULMER EUGEN ISBN-10: 3800176114
ISBN-13: 9783800176113
H. Kramer, A. Akca, 1995, Leitfaden zur Waldmesslehre (Guide for Forest Mensuration) published by: Sauerländer, J D; edition: 3rd expanded and improved ed.
Burschel, P. & Huss, J. 1987. Grundriss des Waldbaus (Ground Plan of Silviculture). Ein Leitfaden für Studium und Praxis (A Guide for Study d Practice). Parey, Hamburg und Berlin. 352 S.
Elverfeldt, Freiherr von A.
Rittershofer, F. 1999. Waldpflege und Waldbau (Forest Management and Silviculture). Für Studium und Praxis (For Study and Practice). Gisela Rittershofer Verlag, Freising. 492 p.

**Responsible for Module:**
Hubert Röder

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

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

# Module Description

## CS0028: Physics | Physics [Phys]

Version of module description: Gültig ab winterterm 2024/25

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

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

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

**Repeat Examination:**
End of Semester

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

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

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

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

**Media:**
Writing on the board, presentations, slide scripts

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

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

**Responsible for Module:**
Prof. Josef Kainz

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

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

# Module Description

## CS0052: Organic Chemistry | Organic Chemistry [OrgChem]

Version of module description: Gültig ab winterterm 2023/24

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>summer semester |
| **Credits:***<br>5 | **Total Hours:**<br>150 | **Self-study Hours:**<br>90 | **Contact Hours:**<br>60 |

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

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

**Repeat Examination:**
End of Semester

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

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

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

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

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

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

**Responsible for Module:**
Prof. Nicolas Plumeré Dr. Alaa Alsheikh Oughli

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

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

# Module Description

## CS0065: Fundamentals of Thermodynamics | Grundlagen Thermodynamik

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
The exam performance is effected by a written test. The students solve thermodynamical arithmetic problems and answer questions regarding the definitions and relations of thermodynamics. The students prove that they have understood the basic principles of thermodynamics by setting up and solving equations. Non-programmable calculators and a handed-out formulary are allowed aids. Exam duration: 90 minutes.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Mathematics

**Content:**
State variables, thermodynamic system, 1st and 2nd law, equations of state for ideal gases and fluid of constant density, process cycles, efficiencies, phase diagrams of pure substances

**Intended Learning Outcomes:**
After sucessful completion of the module the students know the 1st and 2nd law of thermodynamics; the are able to use thermal and caloric equations of state for ideal substance classes; they unterstand thermodynamic phenomena of phase change and related diagrams; they can apply the ideal gas law and the 1st and 2nd law to technical problems.

**Teaching and Learning Methods:**
The module consists of lectures and parallel tutorials. Contents of the lecture shall be imparted in speech and by presentation. To deepen their knowledge students shall be encouraged to study the literature and examine with regards to content the topics. In the exercises performed as part of the

module learned theory shall directly be applied with a practical orientation by means of arithmetic examples.

**Media:**
Presentations, slide scripts, exercises

**Reading List:**
P. STEPHAN, K. SCHABER, K. STEPHAN, F. MAYINGER: Thermodynamik, Band 1 Einstoffsysteme
16. Auflage, Springer, Berlin (2006); H.D. BAEHR, S. KABELAC: Thermodynamik, 13. Auflage, Springer, Berlin (2006)

**Responsible for Module:**
Jakob Burger burger@tum.de

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

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

# Module Description

## CS0066: Introduction to Process Engineering | Introduction to Process Engineering

Version of module description: Gültig ab winterterm 2024/25

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>summer semester |
| **Credits:***<br>5 | **Total Hours:**<br>150 | **Self-study Hours:**<br>90 | **Contact Hours:**<br>60 |

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

**Description of Examination Method:**
The exam performance is effected by a written test. Through comprehension questions it is reviewed whether the students have understood the basic priciples of process engineering. The students solve balance arithmetic problems and answer questions regarding the definitions and relations of material and energy balances. The students prove that they have understood the basics of conceptual process design by selecting suitable process units for a given separation task and by drawing of the process flowsheet. Non-programmable calculators and a handed-out formulary are allowed aids. Exam duration: 90 minutes.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Mathematics

**Content:**
Most important unit-operations: reactors, distillation, extraction, crystallization, absorption, membranes, filtration, evaporatoin. Material und energy balances of single units and whole processes. Conceptual process design.

**Intended Learning Outcomes:**
After sucessful completion of the module the students know the most important separation technologies of process engineering; the are able to balance them with respect to material and energy; they unterstand basics of reaction engineering; they can safely select unit operations and decribe their mode of operation.

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

**Media:**
Presentations, slide scripts, exercises

**Reading List:**
1. Basic Principles and Calculations in Chemical Engineering, 8th Edition, (David M. Himmelblau, James B. Riggs), Prentice-Hall Inc., New Jersey, 2012.
2. Introduction to Chemical Engineering: Tools for Today and Tomorrow, 5th Edition, (Kenneth A. Solen, John N. Harb), Wiley & Sons Inc., New Jersey, 2010.
3. Elementary Principles of Chemical Processes, 3rd Edition, (Richard M. Felder, Ronald W. Rousseau), Wiley & Sons Inc., New Jersey, 2004.
4. Perry's Chemical Engineers' Handbook, 9th Edition, (Don Green, Marylee Z. Southard), McGraw-Hill Education Ltd., New York, 2018.
5. Chemical Reaction Engineering, 3rd Edition, (Octave Levenspiel), Wiley India Pvt. Ltd., New Delhi, 2017.
6. Thermal Separation Technology: Principles, Methods, Process Design, 1st Edition, (Alfons Mersmann, Matthias Kind, Johann Stichlmair), Springer-Verlag Berlin Heidelberg GmbH, Berlin, 2011.

**Responsible for Module:**
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

## CS0086: Wood-based Resources | Wood-based Resources

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
Exam achievement shall be done in the form of a test. Product pathways of forestry and forest industry shall be reflected here. Classification of economic and ecological aspects of forestry and forest industry from cultivation to material and energetic use shall be explained by using examples of particular cases. Recognition of wood and wood materials shall be shown. The relation of knowledge of forestry and forest industry with regard to knowledge of different woods and wood utilisation will be evaluated at a ratio of 1 to 1. The answers require own formulations from the respective technical jargon of forestry and forest industry.
Type of exam: In writing. Exam duration: 90 minutes

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**

**Content:**
The module aims at providing in-depth knowledge to the students in the field of forestry and forest industry from harvest to the use of wood. Special emphasis is given to the interfaces concerning wood use (sawing, wood materials and paper industry) and energy wood production. In a further aspect differences of woods shall be addressed from a microscopic point of view through to their field of application in the manufacturing industry. Therefore, students learn to classify woods microscopically and macroscopically.

**Intended Learning Outcomes:**
After attending the module the student shall be able to characterise the product pathways in forestry from crop establishment through to material and energetic use of wood. He distinguishes different forms of economy and is able to classify them according to economic, social and

ecological aspects. He recognises differences of woods, knows various new products produced from wood and understands their production paths and their markets.

**Teaching and Learning Methods:**
The course attendance of forestry and wood consists of a lecture and exercises. For this purpose powerpoint presentations amd practical training material shall be used. A study trip to wood processing plants including lectures from qualified personnel providing information
from experience on site with common rounds of questions provides in-depth knowledge of the production paths. A socalled wood block determination, i. e. the determination of wood by means of different genuine wood samples, will be performed by a magnifying glass 10x.

**Media:**
The following forms of media apply: Script, powerpoint, films, for determination exercises also branches and leaves of shrubs to be determined. Study trip to companies with guided tour of processing and treatment of wood. Determination of wood with a magnifying glass 10x.

**Reading List:**
D. Fengel and G. Wegener: Wood. Publisher: De Gruyter, https://doi.org/10.1515/9783110839654
Jörg van der Heide, 2011: Der Forstwirt. (The Forester) Publisher: Ulmer (Eugen); Auflage: 5th edition. (September
26, 2011)
Language: German
ISBN-10: 3800155702
ISBN-13: 978-3800155705; D. Fengel, G. Wegener: Wood Verlag Kessel, www.forstbuch.de

**Responsible for Module:**
Prof. Cordt Zollfrank / Prof. Hubert Röder

**Courses (Type of course, Weekly hours per semester), Instructor:**
Wood-based Resources (Exercise) (Übung, 2 SWS)
Zollfrank C [L], Röder H, Zollfrank C

Wood-based Resources (Lecture) (Vorlesung, 2 SWS)
Zollfrank C [L], Röder H, Zollfrank C
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0101: Renewables Utilization | Renewables Utilization

Version of module description: Gültig ab winterterm 2020/21

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

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

**Description of Examination Method:**
Assessment takes a written examination (90 minutes), with students to unterstand and to apply structure, transformation and use of different renewable resources. Students are required to answer questions using individual formulations and outline structures and reactions. In addition, sample calculations are to be worked out.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
Basic lectures in chemistry; Basics on renewables utilization

**Content:**
Various types of ingredients of renewable raw materials: sugars, polysaccharides, fats and oils, amino acids, proteins, terpenes, aromatics. The following topics will be dealt with in more detail: structure, composition, occurrence, properties, analysis and type of added value or use in various examples.

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

**Teaching and Learning Methods:**
Lecture and accompanying tutorial including individual work on specific examples.

**Media:**
Presentation, script, examples and solutions

**Reading List:**

**Responsible for Module:**
Broder Rühmann

**Courses (Type of course, Weekly hours per semester), Instructor:**
Renewables Utilization (Exercise) (Übung, 2 SWS)
Rühmann B

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

# Module Description

## 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:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter semester |
| **Credits:***<br>5 | **Total Hours:**<br>150 | **Self-study Hours:**<br>90 | **Contact Hours:**<br>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], Banda Vazquez J, Costa Riquelme R, Zieleniewska A

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

# Module Description

## CS0213: Environmental Resources in a Changing World | Environmental Resources in a Changing World

*Resource availability, dependency and sustainable usage*

Version of module description: Gültig ab winterterm 2024/25

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

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

**Description of Examination Method:**
Students demonstrate their knowledge and understanding of the relevance of environmental resources, their limited availability, and approaches for a sustainable usage of resources in form of a written examination (90 minutes). Students deliver definitions, describe and outline relevant processes for selected environmental resources regarding their formation, utilization, supply, and sustainable use.

**Repeat Examination:**
End of Semester

**(Recommended) Prerequisites:**
Knowledge and/or interest in Geology and Physics are valuable.

**Content:**
The course focuses on the different areas of life in which environmental resources play a critical role, such as drinking and irrigation water supply, energy provision, strategic mineral use, or sand as a building material. Thereby, an introduction to relevant expert knowledge such as formation, deposition, and utilization of relevant resources will be made. After understanding the formation of resources, their availability under current and future use in a changing environment can be assessed with special consideration of current and future demand on the resource production/ provision.

**Intended Learning Outcomes:**
After successful completion of the module, students understand the ecological and economic value of different environmental resources, the dependency on these resources, and the pressure

upon these resources through a changing world, such as climate and societal changes. Students comprehend the assessment of consequences of unsustainable resource use.

Students prepare short, practice-oriented tasks individually or in a project team (group work). Thereby, they acquire the ability to view and assess information within a limited period of time and solve practice-oriented questions. The edited information and results are shared with the other participants accordingly with a focus on the successful summary, presentation, and discussion of results.

**Teaching and Learning Methods:**
The content is taught in lectures and presentations. In addition, case studies and exercises will be discussed. Students should be encouraged to individual literature study and discussions on the theme.

**Media:**
Lecture, Power Point presentation, blackboard, case examples, topics prepared by participants, and round-table discussions.

**Reading List:**
H. Hettiarachchi & R. Ardakanian (eds.), 2016: Environmental Resource Management and the Nexus Approach. Managing Water, Soil, and Waste in the Context of Global Change. Springer, Cham.

Dassargues, A. (2018): Hydrogeology: Groundwater Science and Engineering, CRC Press, 1st edition.

Grotzinger, T. & Jordan, T. (2014): Understanding Earth. W.H. Freeman & Company, 7th edition

**Responsible for Module:**
Prof. Thomas Vienken

**Courses (Type of course, Weekly hours per semester), Instructor:**
Environmental Resources in a Changing World (Vorlesung mit integrierten Übungen, 4 SWS) Vienken T [L], Vienken T
For further information in this module, please click campus.tum.de or here.

# Module Description

## CS0220: General Chemistry | Allgemeine Chemie [Chem]

Version of module description: Gültig ab winterterm 2021/22

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

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

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
The achievement of the learning objective is checked by a written examination (examination time: 60min). Up to 10% of the total number of points can be added to the grade of this written examination as bonus points. The results of the online tests held during the semester determine the amount of bonus points. At least 65% of the points in the online test must be achieved in order to receive bonus points. It is not possible to raise the grade from 4.3 or worse to 4.0. This should encourage the students to continuously participate in the lectures and exercises that are very important for them. By means of questions on electrochemical aspects, the students prove that they know the relevant technical terms, designations and contents, have understood the basic interrelationships and can apply their knowledge of the processes taking place within the framework of electrocatalysis, local electrochemistry as well as spectroelectrochemistry. Concrete computational tasks are set for this purpose.

**Repeat Examination:**
End of Semester

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

**Content:**
- Electrochemistry of surface-bound species: The ideal case (Langmuir isotherm) and deviations (Frumkin isotherm). Heterogeneous electron transfer (Laviron formalism) to surface-bound species.
- Local electrochemistry: electrochemistry at microelectrodes, scanning electrochemical microscopy.

- Electrochemistry at the nanoscale: mass transfer & kinetics at heterogeneous electrodes. Applications of nanoparticle-modified electrodes. Single nanoparticle electrochemistry.
- Electrocatalysis: Molecular electrochemistry - theory and practice. Heterogeneous electrocatalysis - theory and practice. Methods in electrocatalysis research (DEMS, ICP-MS, FTIR, Raman, etc). Applications (electrochemistry and electrocatalysis of CO2, O2 and H2).
- Spectro-electrochemistry: coupling of EPR, UV-Vis, IR, Raman spectroscopy with electrochemistry. Electropolymerisation/conducting polymers. Correlation between optical properties, energy levels and redox potentials.

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

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

**Media:**
Presentations, PowerPoint, script.

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

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

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

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

# Module Description

## CS0283: Basics Silviculture | Grundlagen Waldbau [BiS]

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
In a test the students shall give answers to silvicultural issues in their own words and without tools. In doing so definitions of different site characteristics and consequences for silviculture shall be given in short answers. In longer answers different silvicultural concepts shall be illustrated. One or more trees of the twenty economically most important tree types shall be determined by means of clear photos and/or branches with leaves. Type of exam: In writing, Exam duartion: 60 minutes

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
Basics of biology
Basics of plant production
Basic knowledge of plant build-up, nutrient cycles, soil structures.

**Content:**
The module aims at providing to students basic knowledge of cultivation, breeding, harvest of trees as well as botany and dendrology. Special techniques and instruments of silviculture shall be imparted: Techniques of reforestation,
young plantation care,
Thinning,
Pruning, Forestry systems as well as
strategies for timber production with hardwood and softwood tree types.
For this purpose parts of location study and teaching of forest soils with pedogenesis and soil chemistry shall be imparted.

**Intended Learning Outcomes:**
After attending the module the students understand the most important basic forms of forest treatment as well as its ecological special features and the structure and dynamic of forest resources. The students recognize different forest-related tree types and are able to distinguish their demands. After attending this module the students are additionally able to explain different forest soils and different silvicultural farming strategies by using the given information from the fields of forest ecology and location study. Silvicultural techniques shall be recognized and may be used accordingly. The most important forest soil types shall be recognized by means of cross-sections.

**Teaching and Learning Methods:**
The course of basics of silviculture consists of one lecture, preparing and giving a speech for which material research is necessary and first rhetoric skill are trained. A study trip into the forest and lectures held by qualified personnel from practice on site at different stations with common rounds of questions shall open a deeper insight into the topic. For that purpose also first determination exercises shall be performed at the object in the forest. A cut out soil profile serves to recognize theoretically acquired knowledge of soil horizons.

**Media:**
In the course the following media forms shall be used:
Script, powerpoint, films, for lectures also blackboard and flipchart, for determination exercises also branches and leaves to be determined. Study trip.

**Reading List:**
"Burschel, P. & Huss, J. 1987. Grundriss des Waldbaus. Ein Leitfaden für Studium und Praxis. Parey, Hamburg und Berlin. 352 S. Elverfeldt, Freiherr von A.
Rittershofer, F. 1999. Waldpflege und Waldbau. Für Studium und Praxis. Gisela Rittershofer Verlag, Freising. 492 S. "

**Responsible for Module:**
Dr. Alexander Höldrich

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

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

# Module Description

## WZ1929: Cell Biology and Microbiology | Zell- und Mikrobiologie [MiBi]

Version of module description: Gültig ab summerterm 2023

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

## WZ1947: Introduction to Electrochemistry | Einführung in die Elektrochemie

Version of module description: Gültig ab winterterm 2023/24

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

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

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

**Repeat Examination:**
End of Semester

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

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

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

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

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

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

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

**Responsible for Module:**
Prof. Nicolas Plumeré

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

Einführung in die Elektrochemie (Übung) (Übung, 1 SWS)
Plumeré N [L], Höfer T

Einführung in die Elektrochemie (Vorlesung) (Vorlesung, 2 SWS)
Plumeré N [L], Plumeré N

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

# Module Description

## WZ1978: Green Chemistry | Green Chemistry

Version of module description: Gültig ab winterterm 2021/22

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

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

**Description of Examination Method:**
The achievement of the learning outcomes will be tested in a written exam and in a seminar. The students are expected to be able to reproduce the course contents correctly and transfer them to different contexts in written form.
The written exam has a duration of 90 minutes. Aids are not permitted. In addition, the contents of the course will be enhanced in a seminar. The proportion of the written exam to the module grade is 80 %. In the seminar, students analyze selected case studies from current literature in the context of Green Chemistry with respect to their sustainability and present these to their co-students and instructor in an oral presentation with short discussion and a brief written composition. The proportion of the seminar grade to the module grade is 20 %.

**Repeat Examination:**
Next semester

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

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

**Intended Learning Outcomes:**
After completion of the module, the students are able to describe the basic principles of environment-friendly and sustainable production of chemicals and demonstrate them at the

examples of selected process chains. They can determine and present specific resource requirements with respect to energy, raw- and auxiliary materials as well as the yields during production, emissions into air, water and soil, as well as amounts of wastewater and solid waste. They are alse able to couple syntheses to preceding and subsequent processing steps. Thus, they can assess the sustainabilities of production processes autonomously.

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

**Media:**
Lecture, blackboard, slides, group work

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

**Responsible for Module:**
Prof. Herbert Riepl

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

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

# Module Description

## WZ1980: Production of Biogenic Resources | Produktion biogener Ressourcen

Version of module description: Gültig ab winterterm 2023/24

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

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

**Description of Examination Method:**
Exam achievement shall be done in the form of a test. In this test it shall be proved that students are capable of describing important requirement for the required biogenic resources and are capable to devlop important rules for the production of the raw materials in a limited time. On the basis of different examples (e.g. algae productions) and scenarios the students shall discuss pros and cons and the possibilities for the transformation of the different biomass to products.
Type of exam: In writing
Exam duration: 90 min.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
None

**Content:**
The module aims at providing in-depth knowledge to the students in the prodution and cultivation of renewable raw materials. Beside the areal-bound production by agriculture and forest, production processes such as Algae bioreactors where integrated. Differences, advantages and disadvantages and possible perspectives are discussed.
Essential crop characteristics shall be discussed for the treated crops and if required differences shall be addressed by various product use (energy and/or industrial crops). As to crops important performance parameters (yields etc.) shall be debated and integration into a concrete cultivation system (farm) be discussed. For this purpose pros and cons shall be worked out and possible actions shall be discussed for optimizing cultivation. For selected topics current main points of research shall be presented and results discussed.

**Intended Learning Outcomes:**
After having participated in the module units the students know the most important biogenic ressources for renewable raw materials.
- They are capable of describing important requirement for the required biogenic resources and are capable to devlop important rules for the production of the raw materials
- For the desired raw materials, the required starting materials or biomass can be described (e.g. in the form of agricultural crops (example starch production: cereals, maize)). Based on the agricultural and wood procution of raw materials students can characterize the cropping system and cultivation methods
- They are able to describe possible effects on the environment for selected main crops (cereals, corn, oil crops)
- The students know selected research activities in the field of renewable raw materials and are able to analyse their results concerning their relevance and significance

**Teaching and Learning Methods:**
The module shall primarily be held as a lecture. For different courses it will be completed by individual and group projects. Demonstration of research activities and presentation of the cultivation by practitioners is partly performed by external guests (lecture, presentation). Further reading and questions for follow-up will be made available for different teaching units in moodle.

**Media:**
Lecture, presentations, (individual and group projects)

**Reading List:**
Lütke- 2006: Lehrbuch des Pflanzenbaus, Band 2: Kulturpflanzen, Verlag Th. Mann Gelsenkirchen.
Diepenbrock, Ellmauer, Leon, 2009 : Ackerbau, Pflanzenbau und Pflanzenzüchtung. Ulmer Verlag.
Pflanzenbau, Ein Lehrbuch - Biologische Grundlagen und Technik der Pflanzenproduktion,
Gerhard Geisler, Paul Parey Verlag: Parasitäre Krankheiten und Schädlinge an landwirtschaftlichen Kulturpflanzen, Ulmer Verlag, G.-M. Hoffmann und H. Schmutterer
Diepenbrock 2014: Nachwachsende Rohstoffe, Ulmer UTB, Stuttgart
Kaltschmitt etal. 2009: Energie aus Biomasse, Springer, Heidelberg

**Responsible for Module:**
Prof. Cordt Zollfrank

**Courses (Type of course, Weekly hours per semester), Instructor:**
Produktion biogener Ressourcen (Vorlesung, 4 SWS)
Höldrich A [L], Höldrich A
For further information in this module, please click campus.tum.de or here.

# General Electives | General Electives

## 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:**<br>Bachelor | **Language:**<br>English | **Duration:**<br>one semester | **Frequency:**<br>winter/summer semester |
| **Credits:***<br>3 | **Total Hours:**<br>90 | **Self-study Hours:**<br>60 | **Contact Hours:**<br>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

## MGT000159: Business Plan - Basic Course (Business Idea and Market) | Business Plan - Basic Course (Business Idea and Market)

Version of module description: Gültig ab summerterm 2024

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

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

**Description of Examination Method:**
The examination consists of the preparation of a semester-long project work (business idea) as a team. It consists of the written preparation of a business plan (7-10 pages in length, with specified topic contributions per team member, accounting for 30% of the assessment) and a final presentation (duration: 8 minutes pitch and 8 minutes Q&A, with equaly distributed presentation parts per team member, accounting for 70% of the assessment). The presentation contains, among other things, the most important learnings from the customer interviews and the demonstration of an interactive prototype of the developed product or service.

The project work assesses the extent to which students can identify and implement business opportunities. The business plan presents in a precise and structured way how well the participants have analyzed and understood the needs of their customer. The business plan also examines whether students are able to identify markets for their business idea and analyze market entry opportunities and market positioning. The preparation of initial sales and cost estimates shows whether the students are able to develop a viable business model. In the final presentation, each participant must explain their understanding of this content and defend it in front of the expert jury.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
- Knowledge: No special requirements, willingness to participate
- Abilities: Identifying opportunities; team work; communication; commitment; reliability - Skills: openness; analytical thinking; visual thinking; self-motivation

**Content:**
In iterative, feedback-driven steps, participants learn to think through and present a business idea for solving a customer problem in a structured manner in the form of a business plan. The basic chapters of a business plan listed below are developed for this purpose. The participants network with people from the start-up environment at TUM.

- Brief description of the business idea in the executive summary
- Detailed description of the understanding of the problem, including insights gained from interviews into the needs structure of paying customers and non-paying users
- Detailed description of the developed solution, including documentation of the prototype implementation and substantiation with feedback gained from customers and users
- Comprehensive analysis of the respective market, entry opportunities, competitive analysis and positioning in the market
- Development of a business model suitable for the business idea, including initial sales and cost estimates as well as approaches for successful legal protection

**Intended Learning Outcomes:**
After participating in the module, students are able to
- Identify a real customer problem through feedback, field studies and contextual observations and create a customer benefit with the proposed solution idea
- Recognize opportunities and present prototypical business concepts, e.g. with the help of a business plan
- Evaluate ideas and recognize business opportunities
- Segment markets and identify and characterize potential niche markets
- Develop a business model that includes a clear positioning in the market and a clear differentiation from competitors
- Present their business idea convincingly and based on market data
- Demonstrate the product or service using an interactive prototype

**Teaching and Learning Methods:**
Seminar style: The lecturers are entrepreneurs, serial founders, coaches and former managing directors.
- Interdisciplinarity: Participants form cross-study teams to ensure a target-oriented mix of expertise and skills in the team.
- Action Based Learning: All participants are encouraged to take action and learn through experience and an iterative approach.
- Learning-by-doing: Each team pursues a real business idea or a business idea chosen for the seminar (no case study). Particular attention is paid to really understanding the customer, for example through interviews, observation or expert discussions.
- Prototyping: The teams use interactive prototypes to develop their business idea and make it tangible.
- Online networking: The work in the seminar is accompanied by online tools such as Google Classroom, Slack and Zoom to support the work in the team.

- Peer-to-peer pitching: Each team pitches its idea briefly and succinctly to other teams on the course and receives feedback from them. In this way, the teams get to know different business models and business design approaches.
- Presentation training: Each team presents its business idea several times and receives verbal feedback on presentation style and content.

**Media:**
- Videos
- Slides
- Handouts via the Learning Management System
- Slack as a communication solution for efficient teamwork

**Reading List:**
- Horowitz, Ben (2014): The Hard thing About Hard Things, HarperBusiness
- Kawasaki, Guy (2004): The Art of the Start, Penguin Publishing Group
- Moore, Geoffrey A. (2002).: Crossing the Chasm, HarperCollins
- Osterwalder, Alexander / Pigneur, Yves (2010): Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, John Wiley & Sons
- Ries, Eric (2011): The Lean Startup, Penguin Books Limited
- Thiel, Peter (2014): Zero to One: Notes on Startups, or How to Build the Future, Crown Business
- Timmons, Jeffry A. / Spinelli, Stephen (2009): New Venture Creation,7thedition, McGraw Hill Professional

**Responsible for Module:**
Bücken, Oliver; Dipl.-Kfm. (Univ.)

**Courses (Type of course, Weekly hours per semester), Instructor:**
Business Plan - Basic Course (Business Idea and Market) (MGT000159, English) (Seminar, 4 SWS)
Heyde F
For further information in this module, please click campus.tum.de or here.

## Module Description

# AR30317: Lecture Series TUM.wood | Ringvorlesung TUM.wood [TUM.wood]

*From tree to architecture – the value chain of wood*

Version of module description: Gültig ab summerterm 2022

| | | | |
|---|---|---|---|
| **Module Level:**<br>Master | **Language:**<br>German/English | **Duration:**<br>one semester | **Frequency:**<br>one-time |
| **Credits:***<br>3 | **Total Hours:**<br>90 | **Self-study Hours:**<br>60 | **Contact Hours:**<br>30 |

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

**Description of Examination Method:**
A written exam is implemented at the end of the semester.
Answerings questions regarding the content of the lectures is the main aspect of the exam. There ´s a possibility that it contains tasks, which require independant thinking and development of the gained knowledge. Drawing scetches, answering multipe-choice questions and verbalizing your own resolution can be part of the exam.

Length: 90 min.
Tools: dictionary

**Repeat Examination:**

**(Recommended) Prerequisites:**
Es werden rudimentäre Grundkenntnisse im allgemeinen Themenkomplex Wald, Holz, Bauwesen empfohlen.

**Content:**
The lecture series should offer an overview about the relations in the whole value chain of wood and forestry. A holistic approach beyond the limits of the faculties should deepen the understanding for the ecologic, economic, socio-cultural and technical aspects of the topic ‘building with timber’.

**Intended Learning Outcomes:**
After having participated the course the students will be able to:

- understand the important aspects, challenges and strategies of modern silviculture in central Europe
- analyze the ecologic and economic relations between silviculture, wood processing and implementation in the building construction sector
- understand the state of the art in the production of solid timber and timber products
- gain an  insight in the development of biogenic polymers
- gain an overview of the engineers topics of structural design, fire safety and building physics in timber construction
- gain an overview of the implementation fields of timber in building construction (multi storey buildings, timber engineering, construction in existing contexts…)
- understand the most important parameters at construction and design of timber buildings

**Teaching and Learning Methods:**
The interdisciplinary approach of TUM.wood is reflected by its teaching proposition. The aligned programme of the associated departments invites the students of the involved faculties to gain knowledge of the other areas of study. This comprehensive knowledge is presented within a series of lectures given by the different TUM.wood-partners. Referenced projects may show the complexity and conjunction of the diverse topics and relate therory and practice.
The content of the lectures shall be documented by the students themselves. These notes and the slides of the lecutres build the foundation for the exam. The main learning aspect is to understand the imparted knowledge and conncetion the coherences between the presented interdisciplinar topics. Suggestions for advanced literature will be given during the lessons.

**Media:**
Presentations of the lectures will be provided for the exam prepartions.

**Reading List:**
Kaufmann, H. und Nerdinger, W. (2011) Bauen mit Holz - Wege in die Zukunft. Ausstellungskatalog Pinakothek der Moderne. Prestel, München
Kaufmann, H. mit Krötsch, S. und Winter, S. (2021) Atlas Mehrgeschossiger Holzbau. Detail Verlag, München

www.dataholz.eu
www.informationsdienst-holz.de

Weitere projektbezogene Literaturempfehlungen werden zu Beginn der jeweiligen Veranstaltung mitgeteilt.
Je nach Themenschwerpunkt wird ein Handapparat zur Verfügung gestellt.

**Responsible for Module:**
Birk, Stephan; Prof. Dipl.-Ing.

**Courses (Type of course, Weekly hours per semester), Instructor:**
TUM.wood Lecture Series: Exploring the Wood Value Chain (Vorlesung, 2 SWS)

Schuster S [L], Schuster S, Seidl R, Annighöfer P, Ludwig F, Dörfler K, Weber-Blaschke G, van de Kuilen J, Zollfrank C, Benz J, Winter S, Birk S, Nagler F, Eder M
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:**<br>Bachelor | **Language:**<br>German/English | **Duration:**<br>one semester | **Frequency:**<br>winter/summer semester |
| **Credits:***<br>6 | **Total Hours:**<br>180 | **Self-study Hours:**<br>140 | **Contact Hours:**<br>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], Hagleitner F
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:**
Finger, Peter; Dipl.-Ing. agr. (Univ.)

**Courses (Type of course, Weekly hours per semester), Instructor:**
(SOT82701, SOT86701) EuroTeQ Collider. Enhancing Connections for Sustainable Futures (Seminar, 4 SWS)
Wester A ( Finger P, Lehmann D, Schmid H )
For further information in this module, please click campus.tum.de or here.

# Module Description

## WZ1978: Green Chemistry | Green Chemistry

Version of module description: Gültig ab winterterm 2021/22

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

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

**Description of Examination Method:**
The achievement of the learning outcomes will be tested in a written exam and in a seminar. The students are expected to be able to reproduce the course contents correctly and transfer them to different contexts in written form.
The written exam has a duration of 90 minutes. Aids are not permitted. In addition, the contents of the course will be enhanced in a seminar. The proportion of the written exam to the module grade is 80 %. In the seminar, students analyze selected case studies from current literature in the context of Green Chemistry with respect to their sustainability and present these to their co-students and instructor in an oral presentation with short discussion and a brief written composition. The proportion of the seminar grade to the module grade is 20 %.

**Repeat Examination:**
Next semester

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

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

**Intended Learning Outcomes:**
After completion of the module, the students are able to describe the basic principles of environment-friendly and sustainable production of chemicals and demonstrate them at the

examples of selected process chains. They can determine and present specific resource requirements with respect to energy, raw- and auxiliary materials as well as the yields during production, emissions into air, water and soil, as well as amounts of wastewater and solid waste. They are alse able to couple syntheses to preceding and subsequent processing steps. Thus, they can assess the sustainabilities of production processes autonomously.

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

**Media:**
Lecture, blackboard, slides, group work

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

**Responsible for Module:**
Prof. Herbert Riepl

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

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

# Bachelor's Thesis | Bachelor's Thesis

## Module Description

## CS0205: Bachelor's Thesis | Bachelor's Thesis

Version of module description: Gültig ab winterterm 2021/22

| | | | |
|---|---|---|---|
| **Module Level:**<br>Bachelor | **Language:**<br>German/English | **Duration:**<br>one semester | **Frequency:**<br>winter/summer semester |
| **Credits:***<br>12 | **Total Hours:**<br>360 | **Self-study Hours:**<br>360 | **Contact Hours:**<br>0 |

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

**Description of Examination Method:**
The Bachelor's Thesis is a final paper with a duration of 3 months, where the students concentrate on a specific topic in business administration and economics. Here the students frame the state of research and discourse and evolves the own specific topic. Based on scientific knowledge and methodical skills, students autonomously discribe the topic. The Bachelor's Thesis is supported by a professor of the TUM School of Management.

**Repeat Examination:**
Next semester

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

**Content:**
The Bachelor's Thesis focuses on a research topic in business adminstration and economics, usually at the interface to engineering and natural sciences. The Thesis is always supervised by a professor of TUM School of Management, often in co-operation with an organization of industry or research. The topic of the Thesis is created so that it can be treated extensively within three months.

**Intended Learning Outcomes:**
At the end of the module "Bachelor's Thesis" students are able to handle and develop a project in an autonomic, systematic and scientific way. Therefore the students deploys scientific knowledge and methodical skills to the specific subject. They script the state-of-the-art knowledge, based on

research, and classify the findings within the scientific and/or practical discussion. The students are able to cope with new and complex subjects in an autonomous way.

**Teaching and Learning Methods:**
The creation of the thesis encourages the students to deal soundly with a scientific subject. Therefor they apply the knowledge and methodical skills, acquired during the studies, and create an elaborated scientific documentation within the set time frame.

**Media:**
Literature, presentations

**Reading List:**
specific literature based on the topic

**Responsible for Module:**
Prof. Alexander Hübner

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

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

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