Module Catalog

M.Sc.

Academic Programs School of Management Location Straubing
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 191

Fundamentals in Sustainable Management | Fundamentals in Sustainable Management

Research Methods | Research Methods

Module Description

CS0096: Advanced Empirical Research Methods | Advanced Empirical Research Methods

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. There will be two examinations: one written exam with a duration of 60 minutes (no additional tools allowed) and one oral presentation concerning a case-study with a duration of 20 minutes. The weighting factor of both examiniations is 1:1.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Statistics

Content:
Selected statistical methods required for impact analysis in the economics field, e.g. Difference in Difference, Propensity Score Matching, Endogenous Switching Regression, Instrumental Variable Method. Problems of endogeneity and selfselection bias during data collection and analysis. Conception of suitable data collections. The methods will be presented in the lecture. As part of the exercise, its application is carried out on concrete case studies

Intended Learning Outcomes:
After attending the module, students will be familiar with the most important statistical methods in the field of Impact Assessment to address the problem of endogeneity and the selfselection bias in economic and social sciences. They are able to select and execute the appropriate statistical models for specific case studies. They know how to collect data themselves in order to perform such impact assessment. In addition, students are able to understand statistics in scientific literature (peer reviewed journals).

Teaching and Learning Methods:
The lecture and exercise will be done using Powerpoint and R or Stata. In addition, scientifically published studies will be integrated into the lectures. In the exercise, the students themselves analyze data sets that are made available. The results of the case studies are then discussed and questioned individually and / or in groups from different perspectives by the students. Scientific publications using statistical analysis are analyzed and discussed by the students.

Media:
Presentations, slide scripts, Articles

Reading List:
Kleiber & Zeileis (2008): Applied Econometrics with R, Springer; Angrist & Pischke (2009): Mostly Harmless Econometrics: An Empiricist's Companion, Princeton Univers. Press.

Responsible for Module:
Anja Faße

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Empirical Research Methods (Exercise) (Übung, 2 SWS)
Faße A [L], Faße A, Mager G

Advanced Empirical Research Methods (Lecture) (Vorlesung, 2 SWS)
Faße A [L], Faße A, Mager G
For further information in this module, please click campus.tum.de or here.

Module Description

CS0120: Advanced Sustainability and Life Cycle Assessment | Advanced Sustainability and Life Cycle Assessment

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Written exam (90 minutes): Students have to solve problems from the thematic field of the module. They have to prove their ability to use the right vocabulary, apply their knowledge on advanced topics in life cycle and systems thinking, sustainability and and life cycle assessment. Learning aids: pocket calculator.

Alternative: For small groups (<15 students) parts of the exam can be held in case studies which have to be solved in a group. Thereby the students have to prove through the solution of an advanced problem that they are capable to apply methods and approaches of sustainability and life cycle assessment to emerging topics from the field. Weighting: 1:1.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

Content:
The module contains units covering the following topics:
• Systems and life cycle thinking
• LCA following the ISO 14040/14044 and ILCD standards
• Extension of Life Cycle Assessment to Life Cycle Sustainability Assessments
• Advanced Life Cycle Impact Assessment Methods such as for
- Land use and land use change
- Water use
- Resource use
• Attributional and consequential assessments

• Regionalisation of inventories and impact assessments
• Hybrid approaches
• Uncertainty handling
• Interface with Multi Criteria Decision Analysis
• Presentation and visualisation of results
• Handling of data uncertainty
• Current trends and developments
• Software systems and data bases for material flow analysis and life cycle assessment
• Case studies

Intended Learning Outcomes:
The students use advanced concepts and tools of sustainability and life cycle assessment to assess products, services and processesregarding their environmental impacts. Thus, they are able to gain a deeper understanding of their underlying material and energy flows and how they impact the environment. With these competencies development and improvement of systems, products and services can be supported, decision support delivered and communication with stakeholders aided.

Teaching and Learning Methods:
Format: lecture and (computer-based) exercises to introduce the content, to repeat and deepen the understanding as well as practice individually and in groups.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individual assignments and presentation
- Computer lab exercises using LCA software systems and Life Cycle Inventory Data bases.

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

Reading List:
Recommended reading:
• Curran, M.A. (2015): Life Cycle Assessment Student Handbook, Scrivener Publishing:
• Hauschild, M.Z. & Huijbregts, M.A.J. (2015): Life Cycle Impact Assessment (LCA Compendium - The Complete World of Life Cycle Assessment), Springer.
• Klöpffer, W. & Grahl, B. (2014): Life Cycle Assessment (LCA), Wiley-VCH.
• Recent articles from esp. International Journal of Life Cycle Assessment, Journal of Cleaner Production, Journal of Industrial Ecology, Environmental Science and Technology (to be announced in the lecture)

Responsible for Module:
Prof. Magnus Fröhling

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

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

Module Description

CS0098: Operations Research | Operations Research

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

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

Description of Examination Method:
Assessment takes the form of a written examination. In that examination, students must demonstrate their ability to formulate and solve decision models with appropriate methods. Type of assessment: in writing duration of assessment: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor Business administration; advanced knowledge of mathematics and statistics

Content:
The module is divided into six distinctive areas:

Part 1: Basic Concepts
Part 2: Quantitative Modelling
Part 3: Linear Optimization
Part 4: Graph Theorie
Part 5: Integer and Combinatorical Optimization
Part 6: Dynamic Optimization

Intended Learning Outcomes:
The course introduces into the methods and approaches of Operations Research (OR). Operations Research deals with rational bases for decision making by seeking to understand and structure complex business situations and to use this understanding to predict system behavior and improve system performance.

Teaching and Learning Methods:
Lecture (theory), tutorials with group work and presentation

Media:
Seminaristic tution using beamer, overhead projector, flipchart

Reading List:
Hilier, F. and Lieberman, G., Introduction to Operations Research, McGraw-Hill, 2009
Kallrath, J and Wilson, J. M., Business Optimisation using mathematical Programming, London (Macmillan) 1997
Winston, W.: Operations Research - Applications and Algorithms. 4th ed. (internat. student ed.), Belmont, Calif. (Duxbury), 2004.
Taha, H. A., Operations Research, 7th ed., Upper Saddle River, N.J. (Prentice Hall) 2003.
Domschke, W., Drexl, A., Klein, R., Scholl, A, Einführung in Operations Research, Berlin (Springer) 2015.
Domschke, W. et al., Übungen und Fallbeispiele zum Operations Research, Springer, Berlin–Heidelberg, 2015

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Operations Research (Vorlesung mit integrierten Übungen, 4 SWS)
Hübner A [L], Hübner A, Riesenegger L, Roth B
For further information in this module, please click campus.tum.de or here.

Specialization in Management | Specialization in Management

Module Description

CS0060: Business Game in Sustainable Management | Business Game in Sustainable Management

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

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

Description of Examination Method:
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:
Next semester

(Recommended) Prerequisites:
Supply Chain Planning

Content:
The module is an innovative combination of mediation of theoretical background knowledge, practice and experience using the supply chain simulation „The Fresh Connection“. The topics in detail:
- Basics and decision making in supply chain management
- Supplier Management
- Demand Management
- Capacity and Production Management
- Inventory Management and Planning

- Supply Chain Mapping and component characteristics
- Supply Chain Strategy
- Variables and KPI‘s on strategic and tactical level
- External Collaboration

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

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

Media:
Lecture, simulation software, presentations

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

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

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

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

Module Description

CS0113: Innovation in Bioeconomy | Innovation in Bioeconomy

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The grading is based on a written exam (90 Minutes). The written form of the exam allows a comprehensive assessment of students' knowledge and understanding of the principles of innovation management with a focus on bioeconomic questions and concepts. Building on a core understanding of the principles of innovation management, students will answer questions about the more recent innovation concepts that are driven by digitalization and have the ability to explain the adapted strategies and options for firms. They will also be able to assess the relevance of digital technologies and the different options to design digital business models in the context of bioeconomic questions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Entrepreneurship, Introduction to Innovation Management

Content:
The module introduces students into advanced principles of innovation management from a digital and sustainable perspective. Students will be equiped with basic knowledge on:
- content and relevance of digital technologies
- role of ecosystems, plattforms and networks
- design of business models to implement sustainable innovation
- advanced methods to generate and implement innovation

Beyond that, students will engage in break-out group workshops to personally experience the process of developing and evaluating sustainable innovation activities. Students give presentations to the audience and discuss their results.

Intended Learning Outcomes:
Following the completion of the course, the students will be familiarized with theoretical concepts and empirical methods to:
• assess the different forms and contents for organising innovation in the context of digitalization by including broader economic, environmental and societal effects
• derive recommendations about the design and practices of innovation managements and how to implement sustainable innovation
• identify and evaluate digital technologies and design scenarios for firms to implement sustainable innovation

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

Media:
Presentation, Power-Point Slides, Case Studies

Reading List:
Die Reading list ist aus den neuesten Beiträgen relevanter wissenschaftlichen Zeitschriften zusammengestellt, u.a. Academy of Management Journal, Research Policy, Strategic Management Journal und wird den Studierenden zur Verfügung gestellt.

Responsible for Module:
Claudia Doblinger

Courses (Type of course, Weekly hours per semester), Instructor:
Innovation in Bioeconomy (Lecture) (Vorlesung, 2 SWS)
Vedula S [L], Vedula S, Fischer D, Hagenow N

Innovation in Bioeconomy (Exercise) (Übung, 2 SWS)
Vedula S [L], Vedula S, Fischer D, Hagenow N
For further information in this module, please click campus.tum.de or here.

Module Description

CS0128: Corporate Sustainability Management | Corporate Sustainability Management

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Achievement of desired learning objectives shall be verified in a 60 minute written final exam and a 20 minute oral presetation. The students calculate key performance indicators for sustainable management and illustrate decision-making procedures and alternatives based on case studies. They show that they are able to outline and explain business processes of sustainable management. They demonstrate that they are able to answer questions on sustainable management in their own words. The oral presentation shall be assessed according to content and rhetoric aspects. The written final exam shall be integrated into the general assessment by 75% and the oral presentation by 25%.
Type and duration of exam: In writing (60 min) and oral (20 min);

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

Content:
The module of sustainable management includes a detailed discussion about the term of sustainability (four-pillar model) and its historical development. Basic premises for sustainable management or sustainable development shall be derived from it and discussed in the social, political, economical and business context. National, European and international strategies for sustainable economics shall be introduced (e.g. Bioeconomy, Circular Economy, Green Economy, Agenda 21). Furthermore current measuring concepts and key performance indicators for sustainability (e.g. resource productivity, life cycle costing) shall be treated and applied to exemplary products and value chains and discussed in the framework of ""corporate social responsibility reporting"".

Intended Learning Outcomes:
After having participated in the module the students are able to understand sustainability concepts and to compare sustainability-oriented corporate images as a supplement to value added oriented corporate images. They are able to perform sustainability assessments based on current measuring concepts and key performance indicators. They are able to represent products and services within the scope of sustainable forms of economy.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. During the lectures the contents are delivered by presentations and discussions. The lectures are used to convey the theorectical foundations and include conducting some exercises. The students are inspired to improve the acquired knowledge by studying the suggested literature. In the exercises 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, slide scripts

Reading List:
Müller-Christ, G. (2010) Nachhaltiges Management (Sustainable Management). Einführung in Ressourcenorientierung und widersprüchliche Managementrationalitäten (Introduction into Resource Orientation and Contradictory Management Rationalities). Baden-Baden: Nomos
Schellnhuber, H. J.; Molina, M.; Stern, N.; Huber, V.; Kadner, S. (2010): Global Sustainablity. A Nobel Cause. New York: Cambridge University Press
Seliger, G. (2012): Sustainable Manufacturing. Shaping Global Value Creation. Berlin: Springer
Von Hauff, M.; Kleine, A. (2009): Nachhaltige Entwicklung (Sustainable Development). Grundlagen und Umsetzung (Basics and Implementation). München: Oldenburg Wissenschaftsverlag

Responsible for Module:
Hubert Röder

Courses (Type of course, Weekly hours per semester), Instructor:
Betriebliches Nachhaltigkeitsmanagement (Übung) (Übung, 3 SWS)
Röder H [L], Röder H

Betriebliches Nachhaltigkeitsmanagement (Vorlesung) (Vorlesung, 1 SWS)
Röder H [L], Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0169: Sustainable Supply Chain Management | Sustainable Supply Chain Management

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:

Exam: 50%
presentation: 50%

The combination of grading methods is necessary to evaluate the skills acquired in this course
- Written exam: 45 minutes written exam on presentation, recommended readings, and case studies
- Oral report/presentation: Preparation of an reports in tandem teams with presentation and discussion. The report can be provided as slide-based summary of the presentation. Objective is the preparation of and summary of a current research paper in the field of the lecture; the list of papers is provided at the beginning of the course; All parts have to be passed and cannot be retaken

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor Business administration; advanced knowledge of Mathematics, Statistics and Operations Research

Content:
The course covers decision-oriented aspects of SCM and discusses basic concepts, models, and methods for hierarchical planning in supply chains.This course content provides the foundation for a critical examination of planning systems from a theoretical and practical perspective. This builds the foundation to study case studies and papers with respect to sustainability.

Intended Learning Outcomes:
The students:
- know the conceptual structure of supply chain planning and understand basic concepts, models, and methods that are applied in supply chain management
- gain experience in the supply chain management using prevalent software systems and understand scope and limitations in supporting practical decision situations.
- hone their skills with respect to modeling and solving decision problems in sustainable supply chain management.

Teaching and Learning Methods:
Lecture (theory), tutorials with group work and presentation

Media:
Seminaristic tution using beamer, overhead projector, flipchart

Reading List:
Stadtler/Kilger/Meyr (2015): Supply Chain Management and Advanced Planning. Concepts, Models, Software, and Case Studies. 4. Aufl., Springer (Berlin).
Cachon/Terwiesch (2012): Matching Supply with Demand
Chopra/Meindl (2009): Supply Chain Management: Strategy, Planning, and Operation, Global Edition

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

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

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

Module Description

CS0121: Sustainable Production | Sustainable Production [SP]

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Written exam (90 minutes): By solving problems from the thematic field of the module students have to prove their understanding of the management of industrial production processes and technologies under consideration of sustainability aspects. In doing so they have to prove their techno-economic understanding, knowledge on quantitative methods for the analysis, assessment and optimisation of production systems, as well as their analytical and verbal skills in the field. They need to show that they are able to discuss the treated approaches and to derive further research needs. Learning aids: pocket calculator.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

Content:
The module covers inter alia the following topics:
• Sustainability aspects of industrial production and consumption
• Reasons for considering sustainability aspects in production management
• Measuring sustainability of production and operations
• Sustainable product and service design
• Sustainable sourcing
• Sustainable production management
• Sustainability of logistics
• Managing wastes, waste water, air emissions and product returns

Intended Learning Outcomes:
The module aims at enabling students to approach management tasks of production systems under consideration of sustainability aspects. This covers especially , especially the analysis, assessment and optimisation of these using a quantitative systems analysis approach.

The students understand that production and consumption activities have sustainability impacts and why these have to be considered in the management of production systems. They apply quantitative approaches for the analysis, assessment and optimisation of these systems on example planning tasks. They are capable to discuss the approaches critically, derive further development needs and transfer these approaches to other fields.

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

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- 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:
• Stark R; Seliger G, Bonvoisin J (2017): Sustainable Manufacturing - Challenges, Solutions and Implementation Perspectives , Springer
• Reniers G, Sörensen K, Vranken K (2013): Management principles of sustainable industrial chemistry, Wiley VCH
• McKinnon A, Browne M, Piecyk M, Whiteing A (2015): Green Logistics, Kogan Page
• Mangla S, Luthra S, Jakhar S K, Kumar A, Rana N P (2019): Sustainable Procurement in Supply Chain Operations, CRC Press

Further related reading, especially articles in international peer reviewed journals, will be provided in the kick-off meeting of the module.

Responsible for Module:
Magnus Fröhling

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

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

Major | Major

Major Biotechnology and Material Science | Major Biotechnology and Material Science

Specialization in Engineering and Natural Sciences | Specialization in Engineering and Natural Sciences

Module Description

CS0102: Introduction to Game Theory | Introduction to Game Theory

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Assessment takes an oral form (25 minutes). Students show the extent to which they have understood the taught definitions and terminology from the area of cooperative and non-cooperative games. They show to which extend they are able to use games in order to model problems from economics and engineering. They are also expected to apply important solution concepts to concrete games. Students demonstrate their understanding of these solution concepts when answering comprehension questions concerning their properties and the advantages and disadcantages of the different concepts.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Cooperative and non-cooperative games, solution concepts for cooperative games, core, Shapley value, solution concepts for non-cooperative games, pure Nash equilibria, mixed Nash equilibria, dominant strategies, Bayesian games

Intended Learning Outcomes:
Students have aquired basic theoretical and practical knowledge on cooperative and non-cooperative games. They know the basic definitions and terminology and are able to model problems from economics and engineering as games. Students know the most important solution concepts for cooperative games (such as the core and the Shapley value) and non-cooperative games (such as Nash equilibria and dominant strategies). They have gained a good understanding of these concepts and are able to analyze concrete games by using them.

Teaching and Learning Methods:
Lectures introduce basic knowledge; tutorials practice modelling of application problems as games and applying solution concepts to concrete examples.

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

Reading List:
Manfred J. Holler, Gerhard Illing, Stefan Napel - Einführung in die Spieltheorie, 8. Auflage, Springer Gabler, 2019.
Steven Tadelis - Game Theory: An Introduction, Princeton University Press, 2013.
M. J. Osborne and A. Rubinstein - A Course in Game Theory, MIT Press, 1994

Responsible for Module:
Prof. Clemens Thielen

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

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

Module Description

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 2021/22

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

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

Description of Examination Method:
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:
Next semester

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

Content:
The course focuses on the different areas of life at which environmental resources play a critical role, such as drinking and irrigation water supply, energy provision, strategic mineral use (such as rare earth elements) as well as clean land and building materials for healthy living. Thereby, an introduction to relevant expert knowledge such as formation, deposition, and utilization of relevant resources will be made. After understanding formation of resources, their availability under current and future use in a changing environment can be assessed in 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 from these resources and pressure

upon these resources through a changing world, such as climate and societal changes. Students comprehend the application of different sustainability criteria.

Students prepare short, practice-oriented tasks as homework in a project team (group work). Thereby, they acquire the ability to view and assess information within a limited period of time and solve practice-oriented questions. The edited information and results are passed on to the other participants accordingly with the focus on sharing results in the form of a written report as well as team work.

Teaching and Learning Methods:
The content is taught in lectures and presentations. 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 and presented by participants

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:

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

Module Description

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

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester

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

Content:
Relevant topics and techniques of microbial biotechnology: - microbial metabolism (biosynthesis and degradation pathways) - industrial microbiology: production of alcohols, amino and organic acids, vitamins, antibiotics, enzymes, etc. - bioprocessing techniques - metabolic engineering strategies (e.g. optimization of precursor and cofactor availability) - quantitative biology. In the lecture plant biotechnology the most important model and crop plants in biotechnology are presented, classified and their morphological and physiological properties are emphasized. Major questions, methods and solutions will be discussed with thier pros and cons. Current topics will be discussed based on selected original publications. Some of the topics to be discussed: legal

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

Intended Learning Outcomes:
Upon successfull completion of the module, students will be familiar with the principles and techniques of relevant bioprocesses. The students have acquired knowledge of fermentation processes and are able to develop strategies for process control for selected product classes. The students have learned to quantitatively describe microbial growth and fermentation processes and to calculate mass balances. The students have acquired in-depth knowledge of relevant production processes for selected products of industrial biotechnology. The students know the most important methods and applications in plant biotechnology and are able to assess them.

Teaching and Learning Methods:
The contents of the lectures are conveyed by a talk of the lecturer, based on PowerPoint presentations.The blackboard might additionally be used to explain more complex relationships. To a limited extent, this can be supplemented by self-study of the literature mentioned in the lecture. Seminar: recent publications well be selected and briefely discussed with the students, then presented by the students. The presentation will be discussed and evaluated.

Media:
PowerPoint, whiteboard

Reading List:

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2019/20

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

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

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

Repeat Examination:
Next semester

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

Content:
Technologies that generate analyses or predictions based on data can be found in almost all areas of our daily live (e.g. recommender systems, autonomous driving and credit card fraud detection). These methods are also important for analyzing biological and biomedical data, e.g. for finding novel patterns in biological data. to predict the disease state of a patient or the 3D structure of proteins. In this course we will learn the fundamentals of machine learning and will apply these methods on various real-world problems.
The following contents will be treated exemplarily:
• Similarity and Distance Metrics
• Data Preprocessing and Visualization
• Classification
o Nearest-Neighbor
o Perceptron & Adaline
o Logistic Regression
o Decision Tree

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

Intended Learning Outcomes:
The students know the fundamental and most important artifical intelligence, especially machine learning methods and are able to apply them independently on various real-world problems. The students learn the basics of the programming language Python (one of the leading programming languages in the field of machine learning) and are able to implement and apply machine-learning algorithms in Python. In addition, students are able to visualize and interpret different types of data and results independently.

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

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

Reading List:
Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.
Bishop, C. M. (2006). Pattern recognition and machine learning. Springer.
Raschka, S. (2017). Machine Learning mit Python. mitp Verlag.
Friedman, J., Hastie, T., & Tibshirani, R. (2001). The elements of statistical. Springer.

Responsible for Module:
Dominik Grimm

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

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

Module Description

WZ1290: Biological Materials in Nature and Technology | Biological Materials in Nature and Technology

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Written exam of 90 minutes duration.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in geometry and chemistry

Content:
The module Biological Materials in Nature and Technology covers important biological functional materials, based on basic materials scientific knowledge. This encompasses such materials that fulfill, in their biological system, or in a technological application, either in native state, or modified, one or more specific functions. Differences and similarities to classical engineering materials are pointed out. In addition to the modules Bioinspired Materials and Instrumental Analysis, the students learn important methods for structural and property analysis. After a presentation of the classification of biological materials, students- are taught the basic correlations between hierarchical structuring and macroscopic properties. As the most important complex, the influence of hierarchical structuring on the mechanical properties of materials will be discussed. The students learn, which modes of failure can occur in biological systems and how they are influenced. In this context, modification routes for biological materials are shown and discussed.

Intended Learning Outcomes:
After successful completion of the module, the students are enabled to name criteria for a proper usage of biological materials. They can name specialized methods for the analysis of hierarchical structures and the derived material properties and explain the correlations between structure and

external properties. Further, they are able to describe tailored modification routes for biological materials.

Teaching and Learning Methods:
Lecture with discussion and case studies

Media:
Presentation, slides

Reading List:
Structural Biological Materials: Design and Structure-Property Relationships. Eds Elices M, Pergamon-Elsevier Science Ltd, Oxford, (2000).
Fratzl P & Harrington MJ. Introduction to Biological Materials Science. Wiley VCH, Weinheim, Germany, (2015).

Responsible for Module:
Cordt Zollfrank

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester / End of Semester

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

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

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

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

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

Media:
Presentations, lecture notes

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

Responsible for Module:
Cordt Zollfrank

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

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

Module Description

WZ1157: Sustainable Chemistry | Sustainable Chemistry

Version of module description: Gültig ab winterterm 2021/22

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

Media:
Presentation, script, examples

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

Responsible for Module:
Cordt Zollfrank

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Assessment is done in a written examination (90 minutes). Participants of the course solve programming tasks to demonstrate that they are able to apply the methods aquired in the course. By answering questions related to case examples they show that they have learned to put things into their proper context.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor modules Mathematics, Physics, Numerical Methods;
Basic knowledge in Energy technology; basic programming experience (ideally with Matlab)

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

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

Intended Learning Outcomes:
After attending the course the participants understand basic methods for creating models, simulation and optimization. In addition, they are able to apply these methods by creating appropriate program code in Matlab. Furthermore, the participants acquire Matlab programming experience.

Teaching and Learning Methods:
The module consists of a lecture and an excercise. Lectures include presentations whose content is deepened by solving excercise problems autonomously. In order to improve the learning outcome, participants work at homework excercise problems. These are discussed in the next lecture.

Media:
PP presentation, whiteboard, demonstration of programs

Reading List:

Responsible for Module:
Josef Kainz

Courses (Type of course, Weekly hours per semester), Instructor:
Modelling and Optimization of Energy Systems (Vorlesung, 4 SWS)
Kainz J [L], Kainz J
For further information in this module, please click campus.tum.de or here.

Module Description

CS0101: Renewables Utilization | Renewables Utilization

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester

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

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

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

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

Media:
Presentation, script, examples and solutions

Reading List:

Responsible for Module:
Broder Rühmann

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

Einführung in die stoffliche Nutzung / Renewables Utilization (Lecture) (Vorlesung, 2 SWS)
Rühmann B, Sieber V
For further information in this module, please click campus.tum.de or here.

Module Description

CS0110: Enzyme Engineering | Enzyme Engineering [EE]

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
This course aims to convey molecular biology and protein chemistry
approaches to optimize enzymes especially by variation of the primary structure.
Essential contents are: analysis of the limitation at the molecular level, rational methods, computer-based methods, evolutionary and combined procedures, high-throughput methods, robotics. The practical course aims to convey practically molecular biology and protein chemistry methods to optimize enzymes by means of two relevant examples. Essential contents are: 1. Rational/ computer-based approach - site-directed (random) mutagenesis by means of sequence comparisons, structural analyzes and computer models, 2. Purely evolutionary approach: undirected mutagenesis. For both approaches assay methods are established.

Intended Learning Outcomes:
After participating in the lecture the students will be able to indicate options for the improvement of technically limited enzymes, to estimate the necessary effort for this improvements and
they own the theoretical ability to put these improvements in the following internship Enzyme Engineering into practice. After having participated in the practical course the students are able to

perform different methods of enzyme optimization and thereby especially the essential elements (production of variants, structure/ screening of the assay, operation of necessary hardware) practically.

Teaching and Learning Methods:
The lecture will be performed as ex-cathedra teaching to provide the students with all necessary fundamentals. In addition, the students review single methods and procedures by themselves e.g. based on current scientific literature and present this review to each other in a presentation. The practical work is carried out under close supervision where some of the experiments are prepared by the students themselves to promote their own planning skills.

Media:
PowerPoint, script, internship scripts

Reading List:

Responsible for Module:
Volker Sieber

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

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

Module Description

CS0009: Enzymatic Biotransformations | Enzymatic Biotransformations [IBT]

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
To prove whether the students are able to understand and to describe possibilities and limitations of established industrial enzymatic processes and whether they are able to apply this knowledge to derive ways to improve existing processes, making them more sustainable and to establish new ones), a written examination takes place with a duration of 90 minutes (approved tool: calculator). A bonus of 0,3 is credited on the grade of this written examination when during the module at least 65% of the exercise sheets are handed in and are marked with a positive result (an increase of the grade from 4,3 to 4,0 is not possible). Thereby students shall be motivated to participate in the exercise which is very important for them.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

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

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

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

Media:
PowerPoint, white board, exercise sheets

Reading List:

Responsible for Module:
Voker Sieber

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

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

Module Description

CS0086: Wood-based Resources | Wood-based Resources

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
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:
Next 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:
Jörg van der Heide, 2011: Der Forstwirt. (The Forester) Publisher: Ulmer (Eugen); Auflage: 5th edition. (September
26, 2011)
Language: German
ISBN-10: 3800155702
ISBN-13: 978-3800155705; D. Fengel, G. Wegener: Wood Verlag Kessel, www.forstbuch.de

Responsible for Module:
Prof. Cordt Zollfrank

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

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

Module Description

CS0026: Advanced Concepts of Bioinformatics | Advanced Concepts of Bioinformatics

Version of module description: Gültig ab winterterm 2019/20

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

Responsible for Module:
Dominik Grimm

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

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

Module Description

CS0134: Conceptual Process Design | Conceptual Process Design

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

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

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

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

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

Media:
Panel, slides, scripts, practical exercises

Reading List:

Responsible for Module:
Jakob Burger burger@tum.de

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

Conceptual Process Design (Exercise) (Übung, 2 SWS)
Burger J [L], Burger J, Ferre A, Göttl Q
For further information in this module, please click campus.tum.de or here.

Module Description

CS0003: Production of Alternative Fuels | Production of Alternative Fuels

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
The learning results are going to be proven in form of an oral exam that consists of two parts: (a) 30 minutes preparation through solving a given problem set (b) 30 minutes of oral examination. In the beginning of part (b) the results of part (a) are presented by the student. Along the problem set it is checked whether the student is able to understand, improve and assess indsutrial processes for the production of alternative fuels. No aids permitted. Total examination duration: 60 Minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Technology of Chemical Processes (WZ1617) or comparable

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

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

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

Media:
Lecture notes, slides, excersises

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Production of alternative fuels (Lecture, Straubing) (Vorlesung, 2 SWS)
Burger J [L], Burger J, Göttl Q

Production of alternative fuels (Tutorial, Straubing) (Übung, 2 SWS)
Burger J [L], Burger J, Göttl Q

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

Production of alternative fuels (Tutorial, Garching) (Übung, 2 SWS)
Burger J [L], Burger J, Göttl Q
For further information in this module, please click campus.tum.de or here.

Module Description

CS0170: Advanced Modelling and Optimization | Advanced Modelling and Optimization

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**Contact Hours:** 60

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

Description of Examination Method:
The examination is based on two project works (each 50% of evaluation).

The project works examine the understanding of the modeling and programming techniques discussed in the course. The project works includes, appling algorithms to solve problems, creating mathematical models for examplary problems, and discuss presented results. By this the students have to demonstrate that they have understood and can apply the mathematical models and methods to solve planning problems. The project paper serves the assessment of the understanding of the modeling and programming language.

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

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

Repeat Examination:

(Recommended) Prerequisites:
Operations Research (CS0098)

Content:
This course is about modeling, solving and analyzing planning and decision problems using mathematial concepts. The course teaches the basics of linear, discrete and dynamic optimization. In addition, there is an introduction to optimization and corresponding programming languages, as well as teaching methods for analyzing and structuring algorithms, designing suitable object-oriented data structures, applying known standard algorithms and connecting them to other resources and programming environments.

Intended Learning Outcomes:
After successful completion of the module students are capable of modelling planning problems. Students learn to model real life business problems by applying mathematical programming techniques. They can independently implement mathematical models by using an optimization language and heuristical approaches. They are able to solve the models within the scope of a case study and can interpret the results. Furthermore, they deepen their knowledge in several different modeling techniques and basics of object oriented programming.

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

Media:
Script, Presentation slides

Reading List:
Hilier, F. and Lieberman, G., Introduction to Operations Research, McGraw-Hill, 2009
Popp, Andreas: Modellierung und Optimierung mit OPL. epubli, 2015
Schildt, H.: Java, A Beginner's Guide, 5th Edition, McGraw-hill, 2011
Winston, W.: Operations Research - Applications and Algorithms. 4th ed. (internat. student ed.), Belmont, Calif. (Duxbury), 2004.

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

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
To proof whether the students are able to understand and to describe more complex enzymatic reaction mechanisms and deduce starting points for new enzymes from that, a written examination takes place with a duration of 60 minutes. A bonus of 0,3 is credited on the grade of this written examination when during the module at least 65% of the exercise sheets are handed in and are marked with a positive result (an increase of the grade from 4,3 to 4,0 is not possible). Thereby students shall be motivated to participate in the tutorial which is very important for them.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

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

Intended Learning Outcomes:
After participating in the module sessions, students will be able to understand which complex catalytic mechanisms proceed in enzymes and how they are analyzed. This enables them to assess which chemical reactions are enzymatically possible and which non-natural modifications

are necessary to establish new reactions. Thus, the students can for example open up the function of newly found enzymes and develop new enzymes

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

Media:
PowerPoint, script, task sheets

Reading List:

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

Courses (Type of course, Weekly hours per semester), Instructor:
Chemistry of Enzymes (Seminar) (Seminar, 1 SWS)
Sieber V [L], Al-Shameri A, Hupfeld E, Schmermund L

Chemistry of Enzymes (Lecture) (Vorlesung, 2 SWS)
Sieber V [L], Al-Shameri A, Hupfeld E, Schmermund L
For further information in this module, please click campus.tum.de or here.

Module Description

CS0104: Biogenic polymers | Biogenic polymers [Bioplar]

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
During the seminar, students independently work on a topic from the field of biogenic polymers, and give an oral presentation. Group work is optional. Assessment requires an oral examination (30 minutes). Students demonstrate their knowledge of physico-chemical properties of biogenic polymers as well as possible applications. Students are able to develop options for chemical synthesis and analysis of physico-chemical properties of bioplastics. No further tools are allowed in the examination.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in "Basics in Chemistry" and knowledge of materials and chemical compounds, or comparable knowledge on chemistry and physics.

Content:
The module deals with structure and function of natural bio-macromolecules (in particular polysaccharids and proteins). Furthermore, basics of biogenic polymers will bei discussed in the view of polymers holding potential for applications in future technology. The topic of chemical synthesis and derivatization of bioplastics for use in industry is introduced (e.g. cellulose derivatives). Special focus is set on the development of options for chemical synthesis and its competent application. Physico-chemical properties of bioplastics as well as their characterization is central to the lecture.
The seminar takes the form of a journal club with students independently work on reserach papers and their presentation to fellow students.

Intended Learning Outcomes:
After participation, students are able to classify different kinds of bioplastics with respect to their possible application. They are competent to evaluate the production processes of biopolymers used in technology and can classify them according to their profile of properties. The module enables students to decide on appropriate synthesis methods to meet specific requirements in the industry. Students will also be able to use physico-chemical analysis methods in a competent way.

Teaching and Learning Methods:
Lecture (talks given by teaching staff using PowerPoint media, books and additional written document), seminar (independent work on a topic including a presentation, peer instruction and constructive criticism)

Media:
Presentations, slide notes

Reading List:
Endres, H.J., Seibert-Raths, A., Technische Biopolymere, Carl Hanser Verlag, München, 2009

Responsible for Module:
Cordt Zollfrank

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

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

Electives in Management and Technology | Electives in Management and Technology

Module Description

CS0116: Markets for Energy and Biobased Products | Markets for Energy and Biobased Products

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination will be given in the form of a oral examination as well as students' presentation. The students should be able to evaluate and use the taught methods of market analysis. In addition, questions related to the market development and important influencing factors on markets of energy and biobased products are discussed in the oral examination. No additional tools are allowed during oral examination. Duration of oral examination: 20 minutes. The proportion of the oral examination is 70% of the total grade.
The students' presentation aims to present the scientific methods and results of a student project elaborated during the semester. The students present individually or in groups the elaborated results and discuss them with their colleagues and lecturers. Powerpoint and presentation equipment are allowed for this presentation. Duration of presentation: 30 minutes. The proportion of the presentation is 30% of the total grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Micro-economics

Content:
The content of the module comprises of theory and tools for analysing markets. This knowledge will be used to analyse the development, situation and important determinants of market development in selected energy markets and markets for biogenic products. Thereby the different markets will be regarded from raw material production over the entire value chain to the (private)

consumers. In the energy field, markets for fossile raw materials (e.g. crude oil, natural gas, coal) will be considered as well as markets for regenerative energy production (e.g. wind, hydro, solar energy, use of biomass) for heating, mobility and power. In addition, selected markets for material use of biogenic resources will be covered (like e.g. bulk chemicals, biogenic insulation materials, biogenic polymers, WPC, bioplastics, biocosmetics, detergents and cleaning material, biobased consumer products). Besides, the students will use the taught methods and tools in a students' project in which actual questions related to the market situation and development in selected markets will be analysed.

Intended Learning Outcomes:
After attending the module, students will be able to analyse the developments of markets as well as to select and use the adequate methods in a targeted way. Students are familiar with the relevance, size, development and important influencing factors on the energy markets as well as markets for material use of biogenic resources. They are able to independently analyse these markets, to interprete important determinants of market development, and to assess 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 für 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. In the students' project, students use the taught market analysis methods and tools as well as their factual knowledge to analyse actual questions and developments on selected markets. They will present and discuss their approach and solutions with their colleagues and the lecturers.

Media:
Presentations, slide scripts, Articles

Reading List:

Responsible for Module:
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

CS0125: Plant and Technology Management | Plant and Technology Management [PTM]

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Written exam (90 minutes): By solving problems from the thematic field of the module students have to prove their understanding of the management of industrial plants and technologies, their ability to techno-economic assessment and optimization methods and their analytical and verbal skills in the field. In the solution of the problems they need to demonstrate their ability to analyse technical systems, assess them from an economic point of view and apply techno-economic methods to solve planning and optimization problems arising in the life cycle of these plants.
In addition, they need to show that they are able to discuss the application of these methods in practice and to derive further research needs. Learning aids: pocket calculator.

Alternative: For smaller groups (<15 students) parts of the examination can be held in form of a case study. In this case studies, students have to demonstrate in a group work that they acquired the above mentioned abilitites by solving problems of practical relevance. This acknowledges the complexity of real world problems and the necessity to solve these in (interdisciplinary) team works. With the case study solution students have to provide a statement of the individual contributions to the solutions. Weighting: 1:1.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

Content:
The module contains units covering the following topics:
• Introduction to Plant and Technology Management
• Life cycle of industrial plants

• Analysis and modelling of industrial production systems
• Project management in engineering
• Network and facility location planning
• Investment estimation
• Cost estimation
• Plant and process optimisation
• Maintenance and repair
• Quality Management
• Re-location, dismantling and recycling

Intended Learning Outcomes:
The students are able to solve techno-economic analysis, planning, and optimisation problems associated with the life cycle of industrial plants. This comprises also linked topics of technology assessment and management. After completion of this module the students are able to identify and characterise these problems and structure them. Further, they are able to determine needed data and apply suitable methods for the solution of the problems. They discuss the achievements and shortcomings of these methods for a practical application. They are able to transfer these contents to an application in practice.

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

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

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

Reading List:
Empfohlene Fachliteratur:
1. Chauvel (2003): Manual of Process Economic Evaluation, Edition Technip
2. Couper (2003): Process engineering economics, Marcel Dekker Inc
3. Geldermann (2014): Anlagen- und Energiewirtschaft
4. Goetsch/Davis (2015): Quality Management for Organizational Excellence: Introduction to Total Quality, Pearson
5. Mobley/Higgins/Wikoff (2014): Maintenance Engineering Handbook, McGrawHill
6. Peters/Timmmerhaus/West (2003): Plant Design and Economic for Chemical Engineers, McGrawHill

Weitere Literaturempfehlungen werden in den Veranstaltungen gegeben.

Responsible for Module:
Magnus Fröhling

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

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

Module Description

CS0126: Advanced Seminar in Circular Economy and Sustainability Management | Advanced Seminar in Circular Economy and Sustainability Management [ASCESM]

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**Contact Hours:** 60

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

Description of Examination Method:
"Term paper and presentation: Students have to write a scientific paper on the given topic (15-20 pages). In doing so they have to show that they are capable to find relevant literature, structure a problem, solve it, and document the results of the process in a scientific paper. In the 30 minute final presentation they have to to show that they are able to summarize their findings in a scientific presentation, discuss and defend them (20' for presentation, 10' for discussion).
Weighting: Term paper 2, Presentation 1"

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

Content:
"The module deals with actual topics from Circular Economy and Sustainability Management. These differ from semester to semester. Topics will be announced at the end of the preceeding semester.

Intended Learning Outcomes:
The seminar aims at enabling students for scientific work. After passing the module the sutdents are able to find, structure and analyse relevant literature, solve the problem scientifically, discuss the solution critically, summarize the work in a term paper, hold a scientific presentation, and discuss and defend their work. Thereby the students acquire in-depht knowledge on a current topic from the thematic field of circular economy and sustainability management.

Teaching and Learning Methods:
Seminar: after an introduction on the topic the students carry out a literature research, structure the problem, identify solution approaches, apply these. They summarize their findings in a term paper and a scientific presentation. In this process they are supervised, receive materials, thematic introductions, advise in scientific work and continuous feedback in the seminar sessions. The seminar closes with a final presentation.

Teaching / learning methods:
- Kick-off session: media-assisted presentation
- Individual work and feedback
- Interim presentations / workshops
- Final presentation
- Computer lab exercises using LCA software systems and Life Cycle Inventory Data bases.

Media:
Digital projector, board, flipchart, online contents, recent scientific journal publications, computer lab

Reading List:
Recommended reading:
• Gastel B; Day R A (2017): How to write and publish a sicentific paper, Cambridge University Press
• Glasman-Deal H (2009): Science Research Writing For Non-Native Speakers Of English: A Guide for Non-Native Speakers of English, Imperial College Press
• Skern T (2011): Writing Scientific English: A Workbook, UTB

Topic related reading, especially articles in international peer reviewed journals, will be provided in the kick-off meeting of the module.

Responsible for Module:
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

CS0123: Advanced Seminar in Behavioral Economics | Advanced Seminar in Behavioral Economics

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**Contact Hours:** 60

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

Description of Examination Method:
The examination consists of a written seminar paper and an oral presentation with discussion. The seminar paper should cover 15-20 pages and is written in the style of a journal article. At the end of the module students present their work in a 30 minutes presentation.Weighting: Seminar paper 2, Presentation 1

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

Content:
This advanced seminar focuses on recent developments in Behavioral Economics. After being introduced to adequate research themes in the area of behavioral economics, students explore the academic literature on a chosen topic and develop their own research question. The topics are typically related to human behavior in an economic context and potential behavioral interventions.
Potential topics are:
-Green Nudges
-Social Comparison
-Choice Architecture

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

Specifically, students will learn to:

- Read and understand recent research contributions
- Develop and pursue interesting research questions
- Conduct a literature review
- Eventually, design and conduct an experimental or empirical study
- Write a seminar paper in which they summarize the literature and explain research methods and results
- Present research findings and defend them in a discussion

Teaching and Learning Methods:
In an introductory session, the theme of the seminar is introduced and elaborated in detail. The introduction will also introduce the relevant behavioral economics literature. Based on the introduction, students will develop their own research question and decide on the adequate research methods. During the term students have to reach different milestones (e.g., choose a topic, choose a research method, collect data, outline their paper, write the paper, present the results) on specific dates. Following the submission of the seminar paper, students will present and discuss their research question and findings. During all stages of the seminar students will be assisted by the lecturer(s).

Media:
Research papers; presentation slides

Reading List:

Responsible for Module:
Sebastian Georg

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

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

Module Description

WZ1136: Business Analysis and Management | Unternehmensanalyse und -management

Version of module description: Gültig ab winterterm 2015/16

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

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

Description of Examination Method:
One part of the assessment takes the form of a written examination (60 minutes) with students reflecting the theoretical basics of business analysis. In addition, students are expected to develop a business plan during the course of the semester. The compulsory presentation (30 minutes) contributes to the assessment and will examine the students' ability to put their knowledge of business management into practice. Written examination and oral presentation of the business plan weigh at a ration of 1 to 3, respectively, according to the teaching hours per week.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The lecture is subdivided into two parts:
1. Lectures: business plan in the field of renewable resources
This course involves creating a mock business plan to set up a company. To that end, students work in small groups to develop a business plan which will be presented to the class. The business plan must contain:
- Executive summary
- Business model and concept
- Management team
- Target market, market and competition
- Marketing and sales
- Business system and organization
- Road map for goals

- Opportunities and risks
- Financial planning and financing

2. Lectures: business analysis
Business analysis of selected business areas related to renewable resources (e.g. biogas station with CHP; effects of changed framework conditions), work on case examples

Intended Learning Outcomes:
After their participation, students are aware of basic requirememements to set up a company. Lectures are designed to enhance business thinking. In addition, students can understand relationships in the areas of production technology and business administration relevant to companies in the field of renewable resources.

Teaching and Learning Methods:
Lecture (talks given by teaching staff)
Seminar (students independently study a special topic, with subsequent presentation and final report on it)

Media:
Presentation, excursion

Reading List:
Fueglistaller, Urs; Müller, Christoph A.; Volery, Thierry
:Entrepreneurship, 2., überarb. u. erw. Aufl., Gabler Wiesbaden, 2008.
KALTSCHMITT, M., STREICHER, W. und A. WIESE (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. 4. Aufl., Springer Berlin, 2006. Kuratorium für Technik und Bauwesen in der Landwirtschaft (KTBL): Energiepflanzen. Daten für die Planung des Energiepflanzenanbaus. Darmstadt, 2006. DLG: Die neue Betriebszweigabrechung. Band 197, Frankfurt/Main 2009.

Responsible for Module:
Hubert Röder (hubert.roeder@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Unternehmensanalyse und -management, Vorlesung (Vorlesung, 1 SWS)
Pahl H [L], Pahl H

Businessplan NAWARO (Vorlesung) (Vorlesung, 2 SWS)
Röder H [L], Röder H

Businessplan NAWARO (Übung) (Übung, 1 SWS)
Röder H [L], Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0112: Advanced Seminar in Supply and Value Chain Management | Advanced Seminar in Supply and Value Chain Management

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**Contact Hours:** 60

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

Description of Examination Method:
The examination consists of a written seminar paper, implemented optimization or simulation models as well as an oral presentation & discussion. The seminar paper should cover 15-20 pages and is written in the style of current publications of peer-reviewed journal articles. Accompanied with the seminar paper models have to be implemented to conduct numerical analyses, which will be handed in as a digital appendix. At the end of the module students present their work in a 45 minutes presentation. Weighting: 1:1

Repeat Examination:
Next semester

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

Content:
The advanced seminar focuses on recent research progress on varying topics in service operations, e.g. omni-channel retailing, online retail management. Students identify strategic and operational relationships between supply chain management, marketing and service functions. Thereby, empirical research methods (such as regression models) are applied as well as mathematical optimization and simulation models (such as mixed-integer programming or discrete event simulation) to identify best practice relationships. Several topics with applications in assortment planning, last mile logistics, transportation, inventory management and procurement are available.

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

Specifically, the aim is to be able to:

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

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

Media:
Research paper; presentation slides

Reading List:

Responsible for Module:
Alexander Hübner

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

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

Module Description

WZ1138: Investment, Financing, Money and Capital Markets | Investition, Finanzierung und Kapitalmärkte

Version of module description: Gültig ab winterterm 2015/16

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

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

Description of Examination Method:
Written examination (90 minutes): The students' knowledge is assessed with the help of a comprehensive and coherent case study. This includes students' ability to make and justify investment decisions as well as identify and justify a required financing for investment measures and a necessary use of guarantees.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of (financing) mathematics

Content:
Investment calculation methods / techniques (static, dynamic), instruments for financing and credit insurance, and debtor related problems will be commented with the aid of case examples.
1. Introduction and basics of investment calculation
2.Taxes in investment calculation
3. Optimum replacement time for investment products
4. Uncertainty and sequential decisions
5. Optimum portfolios
6. Financial planning (involves a field trip)
7. Internal financing and self-financing (involves a field trip)
8. External financing (borrowing and own finance)
9. Loan securities
10. Simultaneous investment and programme planning (field trip)
11. Detailed real-life cases

The analysis of case examples is required to ensure that students can make investment decisions independently in their future professional life and will be able to identify the most suitable forms of financing. Ideally, this is not taught in actual classes but by e-learning (individual and group work; chat; fora, students monitoring their own learning)

Individual excursions (to companies and/or financial institutes) offer additional real-life experience.

Intended Learning Outcomes:
Students who have completed this module are aware of the principal methods of static and dynamic investment calculation, including their respective advantages and disadvantages. They can apply those methods to a business context, taking tax into account and using a spreadsheet program.
They are able to calculate and analyze investments offered by companies and derive recommendations for selecting the best offer (from a range of offers).
Students also recognise the potential of companies' internal and external financing (including on the capital market) and the key types of loan securities. They are able to undertake financial planning and evaluate how that might be implemented in a business setting as well as analyse the correct use of common securities relative to the value of the loan.

Teaching and Learning Methods:
Blended Learning inclucing 50 % presence required (lectures, tutorials) and 50 % e-learning (via vhb) with the aid of online exercises, a case study and online tutorials.
Teaching of methods via our own e-learning system (developed for vhb) (starting SS2015) as well as in addition to traditional lectures requiring the students' presence.

Media:
Blackboard, PowerPoint,
e-learning (via vhb) (script, blog, exercise sets)

Reading List:
Bodmer, U.: Geldanlage und Finanzierung. Ulmer Verlag. Stuttgart. 1998.
Drukarczyk, J.: Finanzierung. 10. Auflage. Lucius & Lucius. Stuttgart 2008.
Sachs, G.: Technik der Finanzplanung. In: Hauschildt et al. (Hrsg.): Finanzplanung und Finanzkontrolle. Hagener Universitätstexte. Verlag Vahlen. München.
Zantow, R.: Finanzwirtschaft des Unternehmens; Pearson Verlag.
Zellweger, Th. und U. Fueglistaller: Finanzielles Risiko- und Investitionsverhalten von Familienunternehmen. In: Ernst Young AG und P. Bühler (Hrsg.):Schriften des Family Business Center der Universität Sankt Gallen.2005.
Zellweger, Th. und U. Fueglistaller: Rendite und Spielregeln in Familienunternehmen. In: Ernst Young AG und P. Bühler (Hrsg.):Schriften des Family Business Center der Universität Sankt Gallen.2005.

Responsible for Module:
Ulrich Bodmer (ulrich.bodmer@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Investition, Finanzierung und Kapitalmärkte (Vorlesung, 4 SWS)
Bodmer U [L], Bodmer U, Hertle B
For further information in this module, please click campus.tum.de or here.

Module Description

CS0171: Project Studies | Project Studies

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 12	**Total Hours:** 360	**Self-study Hours:** 330	**Contact Hours:** 30

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

Description of Examination Method:
Grading is based on a project work. The project work consists of a written project report in (30 pages + appendix) and a presentation (30 minutes). A student team of 2-5 students works on a specific problem set within a company or any other similar institution. The team runs through several project stages: problem definition, division of work/tasks, decision making processes, and realization. Throughout this process, the students show that they can develop appropriate strategies to cope with the set of problems. They show that they are able to compose the state of research. In addition they demonstrate their ability to develop their own specific approach for a solution based on scientific knowledge as well as methodical skills. Students demonstrate their ability within a team to manage resources, and deadlines through timely submission of the enumerated tasks. Students demonstrate that they are able to complete the tasks of their project in a team environment. Grading will especially take into account the overall working outcome of the project with respect to the initial problem set, the selection and application of the chosen methodology as well as the analyses and discussion of the main findings. The project work is set up in a way which enables the identification and evaluation of each student's individual contribution to the project's success.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in Business Administration

Content:
The project study consists of a specific problem statement or challenge which a company or any other similar institution is confronted with. This challenge may have a research related or practical character. The project study and its findings regarding the outlined problem set are based on students' academic knowledge gained through their study programs.

Examples of topics covered in the context of a project study include (non-exhaustive list):
- Analyzing potential sales volumes of a new market
- Identifying potential optimization actions regarding a supply chain
- Creating a financing concept for a company
- explaining problems of the logistic sector and developing appropriate optimization solutions
- Developing specific use cases for new electronic payment procedures and deriving appropriate product specifications
- Capturing and processing key performance indicators (KPIs) in controlling and the development of recommended actions
- Developing and conceptualizing a marketing strategy and deriving recommendations for implementation in the given market- or company environment

Intended Learning Outcomes:
After successful participation in the module, students are able to work on projects in a systematic and academic manner. Students are able to complete a project end-to-end throughout all project stages: problem definition, division of work/tasks, development of solutions, decision-making processes, realization, result presentation, and project report. Students obtain capabilities to apply theoretical concepts to the identified problem set and develop their analytical solution finding skills through team discussions. Students are able to exchange in a professional and academic manner within a team. They are able to integrate involved persons into the various tasks considering the group situation. Furthermore, the students obtain competencies in solution processes through their constructive and conceptual acting in a team. Students become able to manage resources, and deadlines through timely submission of the enumerated tasks in stages throughout their research projects.

Teaching and Learning Methods:
The team-based development (2-5 students) of the project solution encourages the students to deal soundly with an academic or practical subject based on their previously acquired academic knowledge. Team work is particularly suitable for tackling problem sets and writing a report, for developing constructive critique to others and for implementing appropriate solutions to these critiques. The project may happen at the premises of the respective company/institution or from a remote location. They are able to communicate the evolvement of the project by composing a project report and preparing a presentation of their solutions to the supervisors from the company as well as the university. The project is supervised jointly by mentors from the respective company/ institution and the professor of the TUM School of Management. The supervision takes place through a kick-off meeting as well as an interim meeting. With regards to content the project study takes an approximate time of 9 weeks.

Media:
literature, presentations

Reading List:
Project Management Institute (2013): A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fifth Edition

Further literature based on the specific topic

Responsible for Module:
Alexander Hübner

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

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

Module Description

CS0111: Advanced Development Economics | Advanced Development Economics

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Micro- and Macroeconomics

Content:
Why are some countries developing and some are trapped in poverty? What are the determinants of economic growth? What is the role of demography, institutions (in particular the state), the environment, labor, migration, capital or credit markets in the development of states? What is the importance of development aid & cooperation? These are some of the questions that decision-makers in the developed and developing countries have to discuss every day. This course provides a theoretical foundation and empirical evidence for the analysis of the most important questions of today's development of the world.

Intended Learning Outcomes:
After visiting the module, the students can use the development economy to understand what is hindering development and what factors lead to success. They can apply theories, concepts, and analytical techniques associated with macroeconomics. Students learn to understand the difference between growth and development, the reasons and impact of migration, the role of institutions (e.g. properte and use rights), development cooperation and international trade. The

students are able to analyze empirical evidence on economic development and to critically read the literature in the field of economic development.

Teaching and Learning Methods:
The lecture and the seminar will be done by PowerPoint. In addition, current examples from newspapers and journals will be integrated into the lectures. In the seminar, the students research current case studies linked to the theories and concepts presented in the lecture. These case studies are then individually and / or groupwise discussed and questioned from different perspectives together with the students. Web lectures by internationally renowned experts and researchers will be integrated into the lecture.

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

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

Responsible for Module:
Anja Faße

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

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

Module Description

CS0114: International Trade | International Trade

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Micro- and Macroeconomics

Content:
Basics of trade theory, such as Gains of Trade are deepened. Effects of customs duties and non-tariff trade barriers, such as environmental standards are presented. It deals with the concept of Pollution Haven and Race to the Bottom. The World Trade Organization and its role in international trade will be presented and discussed on the basis of current trade agreements and conflicts.
In addition, the lecture gives an overview of the effects of trade on international resources consumption. In doing so, empirical trade models (e.g., Gravity Model) are used for clarification.

Intended Learning Outcomes:
Students develop an understanding of theories and empirical methods used in the analysis of international trade. They know how trade policy affects the competitiveness and well-being of society and can apply these methods to the core issues of the globalization debate and sustainable trade.

Teaching and Learning Methods:
The lecture and the seminar will be done by PowerPoint. In addition, current examples of trade policy from the media and journals will be integrated into the lectures. In the seminar, the students research current case studies on the theories and concepts presented in the lecture. These case studies are then individually and / or groupwise discussed and questioned from different perspectives together with the students. Empirical trade models are used and discussed.

Media:
Presentations, slide scripts, Articles

Reading List:
Krugman, Obstfeld (2016) International Economics: Theory and Policy, Global Edition; Michael Todaro, Stephen Smith (2012). Economic Development, Pearson.

Responsible for Module:
Prof. Dr. Anja Faße

Courses (Type of course, Weekly hours per semester), Instructor:
International Trade (Seminar) (Seminar, 2 SWS)
Faße A [L], Faße A

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

Module Description

CS0118: Environmental Accounting in Economics and Sustainability Sciences | Environmental Accounting in Economics and Sustainability Sciences

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental accounting in economics. Example problems will have to be explained, solved and discussed. Type of examination: written, no additional tools allowed, duration of examination: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Micro- and Macroeconomics, Advanced Sustainability and Life Cycle Assessment

Content:
Fundamentals of the national accounts (input-output analysis) and the extension to environmental and social accounts (NAMEA, Social Accounting matrix). Integration of environmental accounts through physical and monetary environmental accounts and their advantages and disadvantages. Execution of multiplier analyzes with Excel. Use of input-output analysis and its environmental extensions for material flow analysis. Dynamic and multi-regional input-output approaches and hybrid Life Cycle Assessment.

Intended Learning Outcomes:
After the module, students will be able to understand and develop the system of national accounts and the integration of environmental accounts (monetary and physical) at national and regional level. They are able to perform and interpret a multiplier analysis. They use advanced methods of input-output analysis to solve problems in material flow analysis.

Teaching and Learning Methods:
The lecture and the tutorial will be done by Powerpoint and Excel. In addition, current examples from scientific journals and data sets will be integrated into the lectures. For advanced examples the use of a mathematical software suite such as Matlab and input-output as well as life cycle inventory databases is intended. These case studies are then analyzed and discussed individually and / or in groups from different perspectives together by the students.

Media:
Presentations, slide scripts, Articles

Reading List:
Taylor (2008): Village Economies: The Design, Estimation, and Use of Villagewide Economic Models. Cambridge University Press; Anguita & Wagner (2010): Environmental Social Accounting Matrices: Theory and Applications, Routledge. Brunner/Rechberger (2017): Handbook of Material Flow Analysis, CRC Press; Miller/Blair (2009): Input-output Analysis: foundations and extensions, Cambridge University Press; and recent journal articles (to be announced in the lectures)

Responsible for Module:
Anja Faße

Courses (Type of course, Weekly hours per semester), Instructor:
Environmental Accounting in Economics and Sustainability Sciences (Lecture) (Vorlesung, 2 SWS)
Faße A [L], Faße A

Environmental Accounting in Economics and Sustainability Sciences (Exercise) (Vorlesung mit integrierten Übungen, 2 SWS)
Faße A [L], Faße A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0119: Behavioral Public Economics | Behavioral Public Economics

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination will be given in the form of a written examination. The students should be able to describe theories, methods and concepts of Behavioral Public Economics. Students should be able to explain important examples from the academic literature. Type of examination: written, calculators are allowed, no additional tools allowed, duration of examination: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Microeconomics, Advanced Microeconomics

Content:
In this course combines public economics with recent contributions of behavioral economics. Students will learn how to apply findings from behavioral economics to the public sector. This course will combine standard models from text books with recent academic papers. We will cover classic theories, their behavioral extensions, and empirical studies. Cover topics will be:
- Welfare Analysis
- Taxation
- Public Goods / Externalities
- Political Economy (Politicians and Voting)
- Public Policy (Savings, Poverty, Health, Environment)

Intended Learning Outcomes:
After attending the module, students will understand current topics in Public Economics and know the relevant insight from behavioral economics. They are capable of applying economic theory to analyze current problems and they can reference the relevant empirical evidence. Students can

analyze and evaluate policy proposals. Based on existing examples they can design and discuss their own policy interventions.

Teaching and Learning Methods:
The lecture will be mostly done by presentations. In addition, articles from newspapers and journals are integrated into the lectures. Together with the lecturer, students will study the content and methods of the academic papers. In the exercises, students will practice solving the learned models. This will either be done jointly on the blackboard or as work in smaller groups. Classroom experiments are carried out for selected topics.

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

Reading List:
Atkinson, A. and Stiglitz, J. (1980), Lectures on Public Economics, McGraw-Hill; reprinted by Princeton University Press (2015).
Gruber, J. (2016) Public Finance and Public Policy, 5th edition, Worth Publishers.
Additional references of academic papers

Responsible for Module:
Sebastian Georg

Courses (Type of course, Weekly hours per semester), Instructor:
Behavioral Public Economics (Lecture) (Vorlesung, 2 SWS)
Goerg S [L], Goerg S

Behavioral Public Economics (Exercise) (Übung, 2 SWS)
Goerg S [L], Goerg S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0176: Service Operations | Service Operations

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
• The examination is carried out in the form of a written test. This should demonstrate that the students can formulate quantitative decision models in the service sector and solve them with suitable methods.
• Type of examination: written
• Exam duration: 60 minutes

Repeat Examination:

(Recommended) Prerequisites:
Content of the module „Operations Research“ is recommended

Content:
• The basic concepts are presented with slide-based lectures. The quantitative models and methods are presented and illustrated by means of examples. Practical applications of service management, e.g. for hospitals, airlines, retail or the service sector.
• These contents form the basis for a critical consideration from a theoretical-conceptual and practical-application-oriented point of view. Current research papers and system-supported case studies are used for this purpose.
• In addition to an introduction to service management, the course also includes location planning, quality management, benchmarking, methods of process optimization, personnel planning, inventory planning and revenue management in the service sector.

Intended Learning Outcomes:
• The students get to know quantitative methods of operations management in the service sector and their application in practice.

• The students learn and understand the basic models and methods for service operations management (especially quality and process management as well as capacity planning) and revenue management (especially price differentiation, capacity control, overbooking control and dynamic pricing). It is also about getting to know the possibilities and limits of the models for use in practice.
• The students deepen their knowledge with regard to the modeling and solving of decision problems in the decision fields mentioned above.

Teaching and Learning Methods:
The basic concepts are presented with slide-based lectures. The quantitative models and methods are presented and illustrated by means of exercise examples, including practical applications in service management, e.g. for hospitals, airlines, retail or in general in the service sector. These contents form the basis for a critical consideration from a theoretical-conceptual and practical-application-oriented point of view. Current research papers, case studies and textbooks are used as the basis for this.

Media:
Presentations, black board work, exercise sheets

Reading List:
• Fitzsimmons, J.A. und M.J. Fitzsimmons: Service Management – Operations, Strategy, and Information Technology. McGraw Hill, New York, 3. Auflage, 2001.
• Klein, R. und C. Steinhardt (2008): Revenue Management – Grundlagen und Mathematische Methoden, Berlin/Heidelberg, Springer
• Talluri, K.T. und G.J. van Ryzin (2005): Theory and Practice of Revenue Management, Boston, Springer

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Service Operations (Exercise) (Übung, 2 SWS)
Hübner A [L], Hübner A

Service Operations (Lecture) (Vorlesung, 2 SWS)
Hübner A [L], Hübner A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0177: Discrete Event Simulation | Discrete Event Simulation

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
The examination consists of two individual tasks and a project work. The individual work is done as homework and is composed as follows:
• R-Statistics homework (10 % of the evaluation)
• AnyLogic homework (10 % of the evaluation)

The project work serves to evaluate the understanding in handling and application of simulations. For the project work the participants receive a randomly assigned extensive fictitious simulation problem. The project work consists of the presentation of the project plan, a project report, an oral presentation of 20 min and a discussion time of 10 min.

The evaluation of the project work is based on the following criteria:
• presentation of the project plan (10 % of the evaluation)
• written documentation of the project work (50% of the evaluation)
• presentation and discussion of the project work (20% of the evaluation)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in mathematics and statistics, especially in probability theory and probability distributions as well as descriptive and inductive statistics

Content:
• Basics of simulation
• Steps in a Simulation Study
• Conceptual Modeling
• Introduction to ARIS: Representation of processes using event-driven process chains

• Data collection and modeling of input data
• Introduction to R: Analysis of distributions
• Modeling and implementation of simulation models
• Introduction to simulation software (e.g. AnyLogic) and basic as well as advanced simulation techniques
• Visualization of simulations
• Verification, Validation and Calibration of a simulation
• Methods for determining the simulation setting
• Statistical methods for the analysis of simulation results

Intended Learning Outcomes:
Students
• apply their knowledge of probability theory and probability distributions
• are able to analyze production and logistic systems, represent processes and design proposals for optimization.
• apply the necessary methodological knowledge for the independent execution of simulation studies.
• are able to apply simulation software such as AnyLogic practically.
• can present results of a simulation study and derive concrete recommendations for action from their analyses.

Teaching and Learning Methods:
The module consists of a lecture and an exercise, which take place weekly. In the lecture, the contents are derived together with the participants. The exercise repeats the lecture contents with examples and deepens core concepts through independent simulation and computational studies of selected problems. The students are supported in solving the exercises by the tutors.

Media:
Presentations, cases and solutions

Reading List:
• Kelton, W. D., R. P. Sadowski, and D. T. Sturrock, Simulation with Arena, 3. Aufl., Boston (McGraw-Hill) 2003.
• Law, A. M. and W. D. Kelton, Simulation Modeling and Analysis, 4. Ed., Boston (McGraw-Hill) 2007.

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Discrete Event Simulation (Lecture) (Vorlesung, 2 SWS)
Hübner A [L], Schäfer F

Discrete Event Simulation (Exercise) (Übung, 2 SWS)
Hübner A [L], Schäfer F
For further information in this module, please click campus.tum.de or here.

Module Description

CS0238: Environmental Behavior and Support for Climate Policies | Environmental Behavior and Support for Climate Policies

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Achievement of desired learning objectives shall be verified in a term paper (max. 10 pages) and an oral presentation in a group. The students will implement their own online survey and present the findings in the context of the relevant literature in a group presentation (each student has to present 10 minutes). The oral presentation shall be assessed according to content and rhetoric aspects. The term paper is written individually and summarizes the relevant literature, empirical method, data, and key findings. Weighting: Term paper 2, Presentation 1.

Repeat Examination:

(Recommended) Prerequisites:

Content:
The successful transition from a fossil fuel economy to a more bio-based and sustainable circular economy requires pro-environmental behavior and public support for long-term climate policies (e.g., climate neutrality by 2050). This course aims to explain the factors of environmental behavior and why citizens support or reject climate change polices. Based on recent empirical findings from psychology and economics, the following factors influencing behavior and policy support are discussed:

- socio-psychological factors and climate change perception (e.g., political orientation, environmental values, risk perception, emotions, etc.),
- the perception of climate policy and design (e.g., perceived costs, perceived fairness, perceived effectiveness, etc.), and
- contextual factors (e.g., social norms, participations, economic and geographical aspects).

The course consists of a lecture that gives an overview of the factors that influence environmental behavior and public support for climate policies. It will also review methodological questions relevant for (online) surveys. In the integrated exercises students will be trained to implement online surveys and experiments. Students will be assigned to groups and conduct their own online survey and investigate factors that influence pro-environmental behavior and the support for climate policies.

Intended Learning Outcomes:
After attending the module, students will understand current topics in the psychology and economics of climate change. They are capable of applying online surveys to analyze the support or rejection towards climate policies and they can reference the relevant empirical evidence. Students can analyze the collected data with the appropriate statistical models. Students learn how to present scientific results in the public. In addition, students learn to write a term paper according to scientific standards.

Teaching and Learning Methods:
The lecture will be mostly done by presentations. In addition, articles from newspapers and journals are integrated into the lectures. Together with the lecturer, students will study the content and methods of the academic papers. In the exercises, the students themselves conduct an online survey and analyze the collected data. The results of the online survey are then presented and discussed individually and / or in groups from different perspectives by the students. Students will reproduce what has been learned in a written work.

Media:
Presentations, Articles

Reading List:
Bibliography of scientific publications

Responsible for Module:
Andreas Pondorfer

Courses (Type of course, Weekly hours per semester), Instructor:
Climate Policies and Behaviour (Vorlesung mit integrierten Übungen, 4 SWS)
Pondorfer A [L], Pondorfer A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0244: Inventory and Transportation Management | Inventory and Transportation Management

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Written exam: 60 minutes written exam on presentation, recommended readings, and case studies

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor Business administration; advanced knowledge of Mathematics, Statistics and Operations Research

Content:
The course covers decision-oriented aspects of logistics and discusses basic concepts, models, and methods for inventory management and transportation planning in supply chains. This course content provides the foundation for a critical examination of logistics systems from a theoretical and practical perspective.

Part A: Introduction
- Terminological Issues of Logistics Management
- Principles of Logistics Management

Part B: Inventory Management
- Basics of Inventory Management
- Lot Sizing
- Safety Stock
- Work-in-Process

Part C: Transportation Management

- Basic Methods for Transport Optimization
- Transportation Planning
- Packaging
- Shortest Rout Problems
- Traveling Salesman and Vehicle Routing

Intended Learning Outcomes:
The students:
- know the conceptual structure of inventory management and transportation planning and understand basic concepts, models, and methods that are applied in industry and logistics applications
- gain experience in the logistics using prevalent decision models, software systems and understand scope and limitations in supporting practical decision situations.
- hone their skills with respect to modeling and solving decision problems in logistics management.

Teaching and Learning Methods:
Lecture (theory), tutorials with group work and presentation

Media:
Seminaristic delivery using beamer, overhead projector, flipchart

Reading List:
Chopra/Meindl (2009): Supply Chain Management: Strategy, Planning, and Operation, Global Edition
Ghiani, G., Laporte, G., Musmanno R. (2013), Introduction to Logistics Systems Management, 2. edition, Wiley
Günther, H.O., Tempelmeier, H. (2020), Supply Chain Analytics
Silver, E. A., Pyke, D. F. und R. Peterson, Inventory Management and Production Planning and Scheduling, 3. edition, New York (Wiley) 1998.

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Inventory and Transportation Management (Lecture) (Vorlesung, 2 SWS)
Hübner A [L], Hübner A

Inventory and Transportation Management (Exercise) (Übung, 2 SWS)
Hübner A [L], Riesenegger L
For further information in this module, please click campus.tum.de or here.

Major Sustainable Management | Major Sustainable Management

Specialization in Engineering and Natural Sciences | Specialization in Engineering and Natural Sciences

Module Description

CS0102: Introduction to Game Theory | Introduction to Game Theory

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Assessment takes an oral form (25 minutes). Students show the extent to which they have understood the taught definitions and terminology from the area of cooperative and non-cooperative games. They show to which extend they are able to use games in order to model problems from economics and engineering. They are also expected to apply important solution concepts to concrete games. Students demonstrate their understanding of these solution concepts when answering comprehension questions concerning their properties and the advantages and disadcantages of the different concepts.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Cooperative and non-cooperative games, solution concepts for cooperative games, core, Shapley value, solution concepts for non-cooperative games, pure Nash equilibria, mixed Nash equilibria, dominant strategies, Bayesian games

Intended Learning Outcomes:
Students have aquired basic theoretical and practical knowledge on cooperative and non-cooperative games. They know the basic definitions and terminology and are able to model

problems from economics and engineering as games. Students know the most important solution concepts for cooperative games (such as the core and the Shapley value) and non-cooperative games (such as Nash equilibria and dominant strategies). They have gained a good understanding of these concepts and are able to analyze concrete games by using them.

Teaching and Learning Methods:
Lectures introduce basic knowledge; tutorials practice modelling of application problems as games and applying solution concepts to concrete examples.

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

Reading List:
Manfred J. Holler, Gerhard Illing, Stefan Napel - Einführung in die Spieltheorie, 8. Auflage, Springer Gabler, 2019.
Steven Tadelis - Game Theory: An Introduction, Princeton University Press, 2013.
M. J. Osborne and A. Rubinstein - A Course in Game Theory, MIT Press, 1994

Responsible for Module:
Prof. Clemens Thielen

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

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

Module Description

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 2021/22

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

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

Description of Examination Method:
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:
Next semester

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

Content:
The course focuses on the different areas of life at which environmental resources play a critical role, such as drinking and irrigation water supply, energy provision, strategic mineral use (such as rare earth elements) as well as clean land and building materials for healthy living. Thereby, an introduction to relevant expert knowledge such as formation, deposition, and utilization of relevant resources will be made. After understanding formation of resources, their availability under current and future use in a changing environment can be assessed in 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 from these resources and pressure

upon these resources through a changing world, such as climate and societal changes. Students comprehend the application of different sustainability criteria.

Students prepare short, practice-oriented tasks as homework in a project team (group work). Thereby, they acquire the ability to view and assess information within a limited period of time and solve practice-oriented questions. The edited information and results are passed on to the other participants accordingly with the focus on sharing results in the form of a written report as well as team work.

Teaching and Learning Methods:
The content is taught in lectures and presentations. 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 and presented by participants

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:

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

Module Description

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

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester

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

Content:
Relevant topics and techniques of microbial biotechnology: - microbial metabolism (biosynthesis and degradation pathways) - industrial microbiology: production of alcohols, amino and organic acids, vitamins, antibiotics, enzymes, etc. - bioprocessing techniques - metabolic engineering strategies (e.g. optimization of precursor and cofactor availability) - quantitative biology. In the lecture plant biotechnology the most important model and crop plants in biotechnology are presented, classified and their morphological and physiological properties are emphasized. Major questions, methods and solutions will be discussed with thier pros and cons. Current topics will be discussed based on selected original publications. Some of the topics to be discussed: legal

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

Intended Learning Outcomes:
Upon successfull completion of the module, students will be familiar with the principles and techniques of relevant bioprocesses. The students have acquired knowledge of fermentation processes and are able to develop strategies for process control for selected product classes. The students have learned to quantitatively describe microbial growth and fermentation processes and to calculate mass balances. The students have acquired in-depth knowledge of relevant production processes for selected products of industrial biotechnology. The students know the most important methods and applications in plant biotechnology and are able to assess them.

Teaching and Learning Methods:
The contents of the lectures are conveyed by a talk of the lecturer, based on PowerPoint presentations.The blackboard might additionally be used to explain more complex relationships. To a limited extent, this can be supplemented by self-study of the literature mentioned in the lecture. Seminar: recent publications well be selected and briefely discussed with the students, then presented by the students. The presentation will be discussed and evaluated.

Media:
PowerPoint, whiteboard

Reading List:

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2019/20

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

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

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

Repeat Examination:
Next semester

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

Content:
Technologies that generate analyses or predictions based on data can be found in almost all areas of our daily live (e.g. recommender systems, autonomous driving and credit card fraud detection). These methods are also important for analyzing biological and biomedical data, e.g. for finding novel patterns in biological data. to predict the disease state of a patient or the 3D structure of proteins. In this course we will learn the fundamentals of machine learning and will apply these methods on various real-world problems.
The following contents will be treated exemplarily:
• Similarity and Distance Metrics
• Data Preprocessing and Visualization
• Classification
o Nearest-Neighbor
o Perceptron & Adaline
o Logistic Regression
o Decision Tree

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

Intended Learning Outcomes:
The students know the fundamental and most important artifical intelligence, especially machine learning methods and are able to apply them independently on various real-world problems. The students learn the basics of the programming language Python (one of the leading programming languages in the field of machine learning) and are able to implement and apply machine-learning algorithms in Python. In addition, students are able to visualize and interpret different types of data and results independently.

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

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

Reading List:
Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.
Bishop, C. M. (2006). Pattern recognition and machine learning. Springer.
Raschka, S. (2017). Machine Learning mit Python. mitp Verlag.
Friedman, J., Hastie, T., & Tibshirani, R. (2001). The elements of statistical. Springer.

Responsible for Module:
Dominik Grimm

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

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

Module Description

WZ1290: Biological Materials in Nature and Technology | Biological Materials in Nature and Technology

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Written exam of 90 minutes duration.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in geometry and chemistry

Content:
The module Biological Materials in Nature and Technology covers important biological functional materials, based on basic materials scientific knowledge. This encompasses such materials that fulfill, in their biological system, or in a technological application, either in native state, or modified, one or more specific functions. Differences and similarities to classical engineering materials are pointed out. In addition to the modules Bioinspired Materials and Instrumental Analysis, the students learn important methods for structural and property analysis. After a presentation of the classification of biological materials, students- are taught the basic correlations between hierarchical structuring and macroscopic properties. As the most important complex, the influence of hierarchical structuring on the mechanical properties of materials will be discussed. The students learn, which modes of failure can occur in biological systems and how they are influenced. In this context, modification routes for biological materials are shown and discussed.

Intended Learning Outcomes:
After successful completion of the module, the students are enabled to name criteria for a proper usage of biological materials. They can name specialized methods for the analysis of hierarchical structures and the derived material properties and explain the correlations between structure and

external properties. Further, they are able to describe tailored modification routes for biological materials.

Teaching and Learning Methods:
Lecture with discussion and case studies

Media:
Presentation, slides

Reading List:
Structural Biological Materials: Design and Structure-Property Relationships. Eds Elices M, Pergamon-Elsevier Science Ltd, Oxford, (2000).
Fratzl P & Harrington MJ. Introduction to Biological Materials Science. Wiley VCH, Weinheim, Germany, (2015).

Responsible for Module:
Cordt Zollfrank

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester / End of Semester

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

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

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

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

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

Media:
Presentations, lecture notes

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

Responsible for Module:
Cordt Zollfrank

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

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

Module Description

WZ1157: Sustainable Chemistry | Sustainable Chemistry

Version of module description: Gültig ab winterterm 2021/22

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

Media:
Presentation, script, examples

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

Responsible for Module:
Cordt Zollfrank

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Assessment is done in a written examination (90 minutes). Participants of the course solve programming tasks to demonstrate that they are able to apply the methods aquired in the course. By answering questions related to case examples they show that they have learned to put things into their proper context.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor modules Mathematics, Physics, Numerical Methods;
Basic knowledge in Energy technology; basic programming experience (ideally with Matlab)

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

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

Intended Learning Outcomes:
After attending the course the participants understand basic methods for creating models, simulation and optimization. In addition, they are able to apply these methods by creating appropriate program code in Matlab. Furthermore, the participants acquire Matlab programming experience.

Teaching and Learning Methods:
The module consists of a lecture and an excercise. Lectures include presentations whose content is deepened by solving excercise problems autonomously. In order to improve the learning outcome, participants work at homework excercise problems. These are discussed in the next lecture.

Media:
PP presentation, whiteboard, demonstration of programs

Reading List:

Responsible for Module:
Josef Kainz

Courses (Type of course, Weekly hours per semester), Instructor:
Modelling and Optimization of Energy Systems (Vorlesung, 4 SWS)
Kainz J [L], Kainz J
For further information in this module, please click campus.tum.de or here.

Module Description

CS0101: Renewables Utilization | Renewables Utilization

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester

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

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

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

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

Media:
Presentation, script, examples and solutions

Reading List:

Responsible for Module:
Broder Rühmann

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

Einführung in die stoffliche Nutzung / Renewables Utilization (Lecture) (Vorlesung, 2 SWS)
Rühmann B, Sieber V
For further information in this module, please click campus.tum.de or here.

Module Description

CS0110: Enzyme Engineering | Enzyme Engineering [EE]

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
This course aims to convey molecular biology and protein chemistry
approaches to optimize enzymes especially by variation of the primary structure.
Essential contents are: analysis of the limitation at the molecular level, rational methods, computer-based methods, evolutionary and combined procedures, high-throughput methods, robotics. The practical course aims to convey practically molecular biology and protein chemistry methods to optimize enzymes by means of two relevant examples. Essential contents are: 1. Rational/ computer-based approach - site-directed (random) mutagenesis by means of sequence comparisons, structural analyzes and computer models, 2. Purely evolutionary approach: undirected mutagenesis. For both approaches assay methods are established.

Intended Learning Outcomes:
After participating in the lecture the students will be able to indicate options for the improvement of technically limited enzymes, to estimate the necessary effort for this improvements and
they own the theoretical ability to put these improvements in the following internship Enzyme Engineering into practice. After having participated in the practical course the students are able to

perform different methods of enzyme optimization and thereby especially the essential elements (production of variants, structure/ screening of the assay, operation of necessary hardware) practically.

Teaching and Learning Methods:
The lecture will be performed as ex-cathedra teaching to provide the students with all necessary fundamentals. In addition, the students review single methods and procedures by themselves e.g. based on current scientific literature and present this review to each other in a presentation. The practical work is carried out under close supervision where some of the experiments are prepared by the students themselves to promote their own planning skills.

Media:
PowerPoint, script, internship scripts

Reading List:

Responsible for Module:
Volker Sieber

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

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

Module Description

CS0009: Enzymatic Biotransformations | Enzymatic Biotransformations [IBT]

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
To prove whether the students are able to understand and to describe possibilities and limitations of established industrial enzymatic processes and whether they are able to apply this knowledge to derive ways to improve existing processes, making them more sustainable and to establish new ones), a written examination takes place with a duration of 90 minutes (approved tool: calculator). A bonus of 0,3 is credited on the grade of this written examination when during the module at least 65% of the exercise sheets are handed in and are marked with a positive result (an increase of the grade from 4,3 to 4,0 is not possible). Thereby students shall be motivated to participate in the exercise which is very important for them.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

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

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

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

Media:
PowerPoint, white board, exercise sheets

Reading List:

Responsible for Module:
Voker Sieber

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

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

Module Description

CS0086: Wood-based Resources | Wood-based Resources

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
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:
Next 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:
Jörg van der Heide, 2011: Der Forstwirt. (The Forester) Publisher: Ulmer (Eugen); Auflage: 5th edition. (September
26, 2011)
Language: German
ISBN-10: 3800155702
ISBN-13: 978-3800155705; D. Fengel, G. Wegener: Wood Verlag Kessel, www.forstbuch.de

Responsible for Module:
Prof. Cordt Zollfrank

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

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

Module Description

CS0026: Advanced Concepts of Bioinformatics | Advanced Concepts of Bioinformatics

Version of module description: Gültig ab winterterm 2019/20

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

Responsible for Module:
Dominik Grimm

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

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

Module Description

CS0134: Conceptual Process Design | Conceptual Process Design

Version of module description: Gültig ab winterterm 2020/21

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

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

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

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

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

Media:
Panel, slides, scripts, practical exercises

Reading List:

Responsible for Module:
Jakob Burger burger@tum.de

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

Conceptual Process Design (Exercise) (Übung, 2 SWS)
Burger J [L], Burger J, Ferre A, Göttl Q
For further information in this module, please click campus.tum.de or here.

Module Description

CS0003: Production of Alternative Fuels | Production of Alternative Fuels

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
The learning results are going to be proven in form of an oral exam that consists of two parts: (a) 30 minutes preparation through solving a given problem set (b) 30 minutes of oral examination. In the beginning of part (b) the results of part (a) are presented by the student. Along the problem set it is checked whether the student is able to understand, improve and assess indsutrial processes for the production of alternative fuels. No aids permitted. Total examination duration: 60 Minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Technology of Chemical Processes (WZ1617) or comparable

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

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

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

Media:
Lecture notes, slides, excersises

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Production of alternative fuels (Lecture, Straubing) (Vorlesung, 2 SWS)
Burger J [L], Burger J, Göttl Q

Production of alternative fuels (Tutorial, Straubing) (Übung, 2 SWS)
Burger J [L], Burger J, Göttl Q

Production of alternative fuels (Tutorial, Garching) (Übung, 2 SWS)
Burger J [L], Burger J, Göttl Q

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

Module Description

CS0170: Advanced Modelling and Optimization | Advanced Modelling and Optimization

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**Contact Hours:** 60

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

Description of Examination Method:
The examination is based on two project works (each 50% of evaluation).

The project works examine the understanding of the modeling and programming techniques discussed in the course. The project works includes, appling algorithms to solve problems, creating mathematical models for examplary problems, and discuss presented results. By this the students have to demonstrate that they have understood and can apply the mathematical models and methods to solve planning problems. The project paper serves the assessment of the understanding of the modeling and programming language.

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

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

Repeat Examination:

(Recommended) Prerequisites:
Operations Research (CS0098)

Content:
This course is about modeling, solving and analyzing planning and decision problems using mathematial concepts. The course teaches the basics of linear, discrete and dynamic optimization. In addition, there is an introduction to optimization and corresponding programming languages, as well as teaching methods for analyzing and structuring algorithms, designing suitable object-oriented data structures, applying known standard algorithms and connecting them to other resources and programming environments.

Intended Learning Outcomes:
After successful completion of the module students are capable of modelling planning problems. Students learn to model real life business problems by applying mathematical programming techniques. They can independently implement mathematical models by using an optimization language and heuristical approaches. They are able to solve the models within the scope of a case study and can interpret the results. Furthermore, they deepen their knowledge in several different modeling techniques and basics of object oriented programming.

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

Media:
Script, Presentation slides

Reading List:
Hilier, F. and Lieberman, G., Introduction to Operations Research, McGraw-Hill, 2009
Popp, Andreas: Modellierung und Optimierung mit OPL. epubli, 2015
Schildt, H.: Java, A Beginner's Guide, 5th Edition, McGraw-hill, 2011
Winston, W.: Operations Research - Applications and Algorithms. 4th ed. (internat. student ed.), Belmont, Calif. (Duxbury), 2004.

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

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
To proof whether the students are able to understand and to describe more complex enzymatic reaction mechanisms and deduce starting points for new enzymes from that, a written examination takes place with a duration of 60 minutes. A bonus of 0,3 is credited on the grade of this written examination when during the module at least 65% of the exercise sheets are handed in and are marked with a positive result (an increase of the grade from 4,3 to 4,0 is not possible). Thereby students shall be motivated to participate in the tutorial which is very important for them.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

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

Intended Learning Outcomes:
After participating in the module sessions, students will be able to understand which complex catalytic mechanisms proceed in enzymes and how they are analyzed. This enables them to assess which chemical reactions are enzymatically possible and which non-natural modifications

are necessary to establish new reactions. Thus, the students can for example open up the function of newly found enzymes and develop new enzymes

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

Media:
PowerPoint, script, task sheets

Reading List:

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

Courses (Type of course, Weekly hours per semester), Instructor:
Chemistry of Enzymes (Seminar) (Seminar, 1 SWS)
Sieber V [L], Al-Shameri A, Hupfeld E, Schmermund L

Chemistry of Enzymes (Lecture) (Vorlesung, 2 SWS)
Sieber V [L], Al-Shameri A, Hupfeld E, Schmermund L
For further information in this module, please click campus.tum.de or here.

Module Description

CS0104: Biogenic polymers | Biogenic polymers [Bioplar]

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
During the seminar, students independently work on a topic from the field of biogenic polymers, and give an oral presentation. Group work is optional. Assessment requires an oral examination (30 minutes). Students demonstrate their knowledge of physico-chemical properties of biogenic polymers as well as possible applications. Students are able to develop options for chemical synthesis and analysis of physico-chemical properties of bioplastics. No further tools are allowed in the examination.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in "Basics in Chemistry" and knowledge of materials and chemical compounds, or comparable knowledge on chemistry and physics.

Content:
The module deals with structure and function of natural bio-macromolecules (in particular polysaccharids and proteins). Furthermore, basics of biogenic polymers will bei discussed in the view of polymers holding potential for applications in future technology. The topic of chemical synthesis and derivatization of bioplastics for use in industry is introduced (e.g. cellulose derivatives). Special focus is set on the development of options for chemical synthesis and its competent application. Physico-chemical properties of bioplastics as well as their characterization is central to the lecture.
The seminar takes the form of a journal club with students independently work on reserach papers and their presentation to fellow students.

Intended Learning Outcomes:
After participation, students are able to classify different kinds of bioplastics with respect to their possible application. They are competent to evaluate the production processes of biopolymers used in technology and can classify them according to their profile of properties. The module enables students to decide on appropriate synthesis methods to meet specific requirements in the industry. Students will also be able to use physico-chemical analysis methods in a competent way.

Teaching and Learning Methods:
Lecture (talks given by teaching staff using PowerPoint media, books and additional written document), seminar (independent work on a topic including a presentation, peer instruction and constructive criticism)

Media:
Presentations, slide notes

Reading List:
Endres, H.J., Seibert-Raths, A., Technische Biopolymere, Carl Hanser Verlag, München, 2009

Responsible for Module:
Cordt Zollfrank

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

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

Electives in Management and Technology | Electives in Management and Technology

Module Description

CS0116: Markets for Energy and Biobased Products | Markets for Energy and Biobased Products

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination will be given in the form of a oral examination as well as students' presentation. The students should be able to evaluate and use the taught methods of market analysis. In addition, questions related to the market development and important influencing factors on markets of energy and biobased products are discussed in the oral examination. No additional tools are allowed during oral examination. Duration of oral examination: 20 minutes. The proportion of the oral examination is 70% of the total grade.
The students' presentation aims to present the scientific methods and results of a student project elaborated during the semester. The students present individually or in groups the elaborated results and discuss them with their colleagues and lecturers. Powerpoint and presentation equipment are allowed for this presentation. Duration of presentation: 30 minutes. The proportion of the presentation is 30% of the total grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Micro-economics

Content:
The content of the module comprises of theory and tools for analysing markets. This knowledge will be used to analyse the development, situation and important determinants of market development in selected energy markets and markets for biogenic products. Thereby the different markets will be regarded from raw material production over the entire value chain to the (private)

consumers. In the energy field, markets for fossile raw materials (e.g. crude oil, natural gas, coal) will be considered as well as markets for regenerative energy production (e.g. wind, hydro, solar energy, use of biomass) for heating, mobility and power. In addition, selected markets for material use of biogenic resources will be covered (like e.g. bulk chemicals, biogenic insulation materials, biogenic polymers, WPC, bioplastics, biocosmetics, detergents and cleaning material, biobased consumer products). Besides, the students will use the taught methods and tools in a students' project in which actual questions related to the market situation and development in selected markets will be analysed.

Intended Learning Outcomes:
After attending the module, students will be able to analyse the developments of markets as well as to select and use the adequate methods in a targeted way. Students are familiar with the relevance, size, development and important influencing factors on the energy markets as well as markets for material use of biogenic resources. They are able to independently analyse these markets, to interprete important determinants of market development, and to assess 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 für 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. In the students' project, students use the taught market analysis methods and tools as well as their factual knowledge to analyse actual questions and developments on selected markets. They will present and discuss their approach and solutions with their colleagues and the lecturers.

Media:
Presentations, slide scripts, Articles

Reading List:

Responsible for Module:
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

CS0125: Plant and Technology Management | Plant and Technology Management [PTM]

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Written exam (90 minutes): By solving problems from the thematic field of the module students have to prove their understanding of the management of industrial plants and technologies, their ability to techno-economic assessment and optimization methods and their analytical and verbal skills in the field. In the solution of the problems they need to demonstrate their ability to analyse technical systems, assess them from an economic point of view and apply techno-economic methods to solve planning and optimization problems arising in the life cycle of these plants.
In addition, they need to show that they are able to discuss the application of these methods in practice and to derive further research needs. Learning aids: pocket calculator.

Alternative: For smaller groups (<15 students) parts of the examination can be held in form of a case study. In this case studies, students have to demonstrate in a group work that they acquired the above mentioned abilitites by solving problems of practical relevance. This acknowledges the complexity of real world problems and the necessity to solve these in (interdisciplinary) team works. With the case study solution students have to provide a statement of the individual contributions to the solutions. Weighting: 1:1.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

Content:
The module contains units covering the following topics:
• Introduction to Plant and Technology Management
• Life cycle of industrial plants

• Analysis and modelling of industrial production systems
• Project management in engineering
• Network and facility location planning
• Investment estimation
• Cost estimation
• Plant and process optimisation
• Maintenance and repair
• Quality Management
• Re-location, dismantling and recycling

Intended Learning Outcomes:
The students are able to solve techno-economic analysis, planning, and optimisation problems associated with the life cycle of industrial plants. This comprises also linked topics of technology assessment and management. After completion of this module the students are able to identify and characterise these problems and structure them. Further, they are able to determine needed data and apply suitable methods for the solution of the problems. They discuss the achievements and shortcomings of these methods for a practical application. They are able to transfer these contents to an application in practice.

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

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

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

Reading List:
Empfohlene Fachliteratur:
1. Chauvel (2003): Manual of Process Economic Evaluation, Edition Technip
2. Couper (2003): Process engineering economics, Marcel Dekker Inc
3. Geldermann (2014): Anlagen- und Energiewirtschaft
4. Goetsch/Davis (2015): Quality Management for Organizational Excellence: Introduction to Total Quality, Pearson
5. Mobley/Higgins/Wikoff (2014): Maintenance Engineering Handbook, McGrawHill
6. Peters/Timmmerhaus/West (2003): Plant Design and Economic for Chemical Engineers, McGrawHill

Weitere Literaturempfehlungen werden in den Veranstaltungen gegeben.

Responsible for Module:
Magnus Fröhling

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

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

Module Description

CS0126: Advanced Seminar in Circular Economy and Sustainability Management | Advanced Seminar in Circular Economy and Sustainability Management [ASCESM]

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**Contact Hours:** 60

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

Description of Examination Method:
"Term paper and presentation: Students have to write a scientific paper on the given topic (15-20 pages). In doing so they have to show that they are capable to find relevant literature, structure a problem, solve it, and document the results of the process in a scientific paper. In the 30 minute final presentation they have to to show that they are able to summarize their findings in a scientific presentation, discuss and defend them (20' for presentation, 10' for discussion).
Weighting: Term paper 2, Presentation 1"

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

Content:
"The module deals with actual topics from Circular Economy and Sustainability Management. These differ from semester to semester. Topics will be announced at the end of the preceeding semester.

Intended Learning Outcomes:
The seminar aims at enabling students for scientific work. After passing the module the sutdents are able to find, structure and analyse relevant literature, solve the problem scientifically, discuss the solution critically, summarize the work in a term paper, hold a scientific presentation, and discuss and defend their work. Thereby the students acquire in-depht knowledge on a current topic from the thematic field of circular economy and sustainability management.

Teaching and Learning Methods:
Seminar: after an introduction on the topic the students carry out a literature research, structure the problem, identify solution approaches, apply these. They summarize their findings in a term paper and a scientific presentation. In this process they are supervised, receive materials, thematic introductions, advise in scientific work and continuous feedback in the seminar sessions. The seminar closes with a final presentation.

Teaching / learning methods:
- Kick-off session: media-assisted presentation
- Individual work and feedback
- Interim presentations / workshops
- Final presentation
- Computer lab exercises using LCA software systems and Life Cycle Inventory Data bases.

Media:
Digital projector, board, flipchart, online contents, recent scientific journal publications, computer lab

Reading List:
Recommended reading:
• Gastel B; Day R A (2017): How to write and publish a sicentific paper, Cambridge University Press
• Glasman-Deal H (2009): Science Research Writing For Non-Native Speakers Of English: A Guide for Non-Native Speakers of English, Imperial College Press
• Skern T (2011): Writing Scientific English: A Workbook, UTB

Topic related reading, especially articles in international peer reviewed journals, will be provided in the kick-off meeting of the module.

Responsible for Module:
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

CS0123: Advanced Seminar in Behavioral Economics | Advanced Seminar in Behavioral Economics

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**Contact Hours:** 60

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

Description of Examination Method:
The examination consists of a written seminar paper and an oral presentation with discussion. The seminar paper should cover 15-20 pages and is written in the style of a journal article. At the end of the module students present their work in a 30 minutes presentation.Weighting: Seminar paper 2, Presentation 1

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

Content:
This advanced seminar focuses on recent developments in Behavioral Economics. After being introduced to adequate research themes in the area of behavioral economics, students explore the academic literature on a chosen topic and develop their own research question. The topics are typically related to human behavior in an economic context and potential behavioral interventions.
Potential topics are:
-Green Nudges
-Social Comparison
-Choice Architecture

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

Specifically, students will learn to:

- Read and understand recent research contributions
- Develop and pursue interesting research questions
- Conduct a literature review
- Eventually, design and conduct an experimental or empirical study
- Write a seminar paper in which they summarize the literature and explain research methods and results
- Present research findings and defend them in a discussion

Teaching and Learning Methods:
In an introductory session, the theme of the seminar is introduced and elaborated in detail. The introduction will also introduce the relevant behavioral economics literature. Based on the introduction, students will develop their own research question and decide on the adequate research methods. During the term students have to reach different milestones (e.g., choose a topic, choose a research method, collect data, outline their paper, write the paper, present the results) on specific dates. Following the submission of the seminar paper, students will present and discuss their research question and findings. During all stages of the seminar students will be assisted by the lecturer(s).

Media:
Research papers; presentation slides

Reading List:

Responsible for Module:
Sebastian Georg

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

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

Module Description

WZ1136: Business Analysis and Management | Unternehmensanalyse und -management

Version of module description: Gültig ab winterterm 2015/16

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

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

Description of Examination Method:
One part of the assessment takes the form of a written examination (60 minutes) with students reflecting the theoretical basics of business analysis. In addition, students are expected to develop a business plan during the course of the semester. The compulsory presentation (30 minutes) contributes to the assessment and will examine the students' ability to put their knowledge of business management into practice. Written examination and oral presentation of the business plan weigh at a ration of 1 to 3, respectively, according to the teaching hours per week.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The lecture is subdivided into two parts:
1. Lectures: business plan in the field of renewable resources
This course involves creating a mock business plan to set up a company. To that end, students work in small groups to develop a business plan which will be presented to the class. The business plan must contain:
- Executive summary
- Business model and concept
- Management team
- Target market, market and competition
- Marketing and sales
- Business system and organization
- Road map for goals

- Opportunities and risks
- Financial planning and financing

2. Lectures: business analysis
Business analysis of selected business areas related to renewable resources (e.g. biogas station with CHP; effects of changed framework conditions), work on case examples

Intended Learning Outcomes:
After their participation, students are aware of basic requirememements to set up a company. Lectures are designed to enhance business thinking. In addition, students can understand relationships in the areas of production technology and business administration relevant to companies in the field of renewable resources.

Teaching and Learning Methods:
Lecture (talks given by teaching staff)
Seminar (students independently study a special topic, with subsequent presentation and final report on it)

Media:
Presentation, excursion

Reading List:
Fueglistaller, Urs; Müller, Christoph A.; Volery, Thierry
:Entrepreneurship, 2., überarb. u. erw. Aufl., Gabler Wiesbaden, 2008.
KALTSCHMITT, M., STREICHER, W. und A. WIESE (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. 4. Aufl., Springer Berlin, 2006. Kuratorium für Technik und Bauwesen in der Landwirtschaft (KTBL): Energiepflanzen. Daten für die Planung des Energiepflanzenanbaus. Darmstadt, 2006. DLG: Die neue Betriebszweigabrechung. Band 197, Frankfurt/Main 2009.

Responsible for Module:
Hubert Röder (hubert.roeder@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Unternehmensanalyse und -management, Vorlesung (Vorlesung, 1 SWS)
Pahl H [L], Pahl H

Businessplan NAWARO (Vorlesung) (Vorlesung, 2 SWS)
Röder H [L], Röder H

Businessplan NAWARO (Übung) (Übung, 1 SWS)
Röder H [L], Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0112: Advanced Seminar in Supply and Value Chain Management | Advanced Seminar in Supply and Value Chain Management

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 150	**Contact Hours:** 60

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

Description of Examination Method:
The examination consists of a written seminar paper, implemented optimization or simulation models as well as an oral presentation & discussion. The seminar paper should cover 15-20 pages and is written in the style of current publications of peer-reviewed journal articles. Accompanied with the seminar paper models have to be implemented to conduct numerical analyses, which will be handed in as a digital appendix. At the end of the module students present their work in a 45 minutes presentation. Weighting: 1:1

Repeat Examination:
Next semester

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

Content:
The advanced seminar focuses on recent research progress on varying topics in service operations, e.g. omni-channel retailing, online retail management. Students identify strategic and operational relationships between supply chain management, marketing and service functions. Thereby, empirical research methods (such as regression models) are applied as well as mathematical optimization and simulation models (such as mixed-integer programming or discrete event simulation) to identify best practice relationships. Several topics with applications in assortment planning, last mile logistics, transportation, inventory management and procurement are available.

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

Specifically, the aim is to be able to:

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

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

Media:
Research paper; presentation slides

Reading List:

Responsible for Module:
Alexander Hübner

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

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

Module Description

WZ1138: Investment, Financing, Money and Capital Markets | Investition, Finanzierung und Kapitalmärkte

Version of module description: Gültig ab winterterm 2015/16

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

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

Description of Examination Method:
Written examination (90 minutes): The students' knowledge is assessed with the help of a comprehensive and coherent case study. This includes students' ability to make and justify investment decisions as well as identify and justify a required financing for investment measures and a necessary use of guarantees.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of (financing) mathematics

Content:
Investment calculation methods / techniques (static, dynamic), instruments for financing and credit insurance, and debtor related problems will be commented with the aid of case examples.
1. Introduction and basics of investment calculation
2.Taxes in investment calculation
3. Optimum replacement time for investment products
4. Uncertainty and sequential decisions
5. Optimum portfolios
6. Financial planning (involves a field trip)
7. Internal financing and self-financing (involves a field trip)
8. External financing (borrowing and own finance)
9. Loan securities
10. Simultaneous investment and programme planning (field trip)
11. Detailed real-life cases

The analysis of case examples is required to ensure that students can make investment decisions independently in their future professional life and will be able to identify the most suitable forms of financing. Ideally, this is not taught in actual classes but by e-learning (individual and group work; chat; fora, students monitoring their own learning)

Individual excursions (to companies and/or financial institutes) offer additional real-life experience.

Intended Learning Outcomes:
Students who have completed this module are aware of the principal methods of static and dynamic investment calculation, including their respective advantages and disadvantages. They can apply those methods to a business context, taking tax into account and using a spreadsheet program.
They are able to calculate and analyze investments offered by companies and derive recommendations for selecting the best offer (from a range of offers).
Students also recognise the potential of companies' internal and external financing (including on the capital market) and the key types of loan securities. They are able to undertake financial planning and evaluate how that might be implemented in a business setting as well as analyse the correct use of common securities relative to the value of the loan.

Teaching and Learning Methods:
Blended Learning inclucing 50 % presence required (lectures, tutorials) and 50 % e-learning (via vhb) with the aid of online exercises, a case study and online tutorials.
Teaching of methods via our own e-learning system (developed for vhb) (starting SS2015) as well as in addition to traditional lectures requiring the students' presence.

Media:
Blackboard, PowerPoint,
e-learning (via vhb) (script, blog, exercise sets)

Reading List:
Bodmer, U.: Geldanlage und Finanzierung. Ulmer Verlag. Stuttgart. 1998.
Drukarczyk, J.: Finanzierung. 10. Auflage. Lucius & Lucius. Stuttgart 2008.
Sachs, G.: Technik der Finanzplanung. In: Hauschildt et al. (Hrsg.): Finanzplanung und Finanzkontrolle. Hagener Universitätstexte. Verlag Vahlen. München.
Zantow, R.: Finanzwirtschaft des Unternehmens; Pearson Verlag.
Zellweger, Th. und U. Fueglistaller: Finanzielles Risiko- und Investitionsverhalten von Familienunternehmen. In: Ernst Young AG und P. Bühler (Hrsg.):Schriften des Family Business Center der Universität Sankt Gallen.2005.
Zellweger, Th. und U. Fueglistaller: Rendite und Spielregeln in Familienunternehmen. In: Ernst Young AG und P. Bühler (Hrsg.):Schriften des Family Business Center der Universität Sankt Gallen.2005.

Responsible for Module:
Ulrich Bodmer (ulrich.bodmer@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Investition, Finanzierung und Kapitalmärkte (Vorlesung, 4 SWS)
Bodmer U [L], Bodmer U, Hertle B
For further information in this module, please click campus.tum.de or here.

Module Description

CS0171: Project Studies | Project Studies

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 12	**Total Hours:** 360	**Self-study Hours:** 330	**Contact Hours:** 30

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

Description of Examination Method:
Grading is based on a project work. The project work consists of a written project report in (30 pages + appendix) and a presentation (30 minutes). A student team of 2-5 students works on a specific problem set within a company or any other similar institution. The team runs through several project stages: problem definition, division of work/tasks, decision making processes, and realization. Throughout this process, the students show that they can develop appropriate strategies to cope with the set of problems. They show that they are able to compose the state of research. In addition they demonstrate their ability to develop their own specific approach for a solution based on scientific knowledge as well as methodical skills. Students demonstrate their ability within a team to manage resources, and deadlines through timely submission of the enumerated tasks. Students demonstrate that they are able to complete the tasks of their project in a team environment. Grading will especially take into account the overall working outcome of the project with respect to the initial problem set, the selection and application of the chosen methodology as well as the analyses and discussion of the main findings. The project work is set up in a way which enables the identification and evaluation of each student's individual contribution to the project's success.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in Business Administration

Content:
The project study consists of a specific problem statement or challenge which a company or any other similar institution is confronted with. This challenge may have a research related or practical character. The project study and its findings regarding the outlined problem set are based on students' academic knowledge gained through their study programs.

Examples of topics covered in the context of a project study include (non-exhaustive list):
- Analyzing potential sales volumes of a new market
- Identifying potential optimization actions regarding a supply chain
- Creating a financing concept for a company
- explaining problems of the logistic sector and developing appropriate optimization solutions
- Developing specific use cases for new electronic payment procedures and deriving appropriate product specifications
- Capturing and processing key performance indicators (KPIs) in controlling and the development of recommended actions
- Developing and conceptualizing a marketing strategy and deriving recommendations for implementation in the given market- or company environment

Intended Learning Outcomes:
After successful participation in the module, students are able to work on projects in a systematic and academic manner. Students are able to complete a project end-to-end throughout all project stages: problem definition, division of work/tasks, development of solutions, decision-making processes, realization, result presentation, and project report. Students obtain capabilities to apply theoretical concepts to the identified problem set and develop their analytical solution finding skills through team discussions. Students are able to exchange in a professional and academic manner within a team. They are able to integrate involved persons into the various tasks considering the group situation. Furthermore, the students obtain competencies in solution processes through their constructive and conceptual acting in a team. Students become able to manage resources, and deadlines through timely submission of the enumerated tasks in stages throughout their research projects.

Teaching and Learning Methods:
The team-based development (2-5 students) of the project solution encourages the students to deal soundly with an academic or practical subject based on their previously acquired academic knowledge. Team work is particularly suitable for tackling problem sets and writing a report, for developing constructive critique to others and for implementing appropriate solutions to these critiques. The project may happen at the premises of the respective company/institution or from a remote location. They are able to communicate the evolvement of the project by composing a project report and preparing a presentation of their solutions to the supervisors from the company as well as the university. The project is supervised jointly by mentors from the respective company/ institution and the professor of the TUM School of Management. The supervision takes place through a kick-off meeting as well as an interim meeting. With regards to content the project study takes an approximate time of 9 weeks.

Media:
literature, presentations

Reading List:
Project Management Institute (2013): A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fifth Edition

Further literature based on the specific topic

Responsible for Module:
Alexander Hübner

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

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

Module Description

CS0111: Advanced Development Economics | Advanced Development Economics

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Micro- and Macroeconomics

Content:
Why are some countries developing and some are trapped in poverty? What are the determinants of economic growth? What is the role of demography, institutions (in particular the state), the environment, labor, migration, capital or credit markets in the development of states? What is the importance of development aid & cooperation? These are some of the questions that decision-makers in the developed and developing countries have to discuss every day. This course provides a theoretical foundation and empirical evidence for the analysis of the most important questions of today's development of the world.

Intended Learning Outcomes:
After visiting the module, the students can use the development economy to understand what is hindering development and what factors lead to success. They can apply theories, concepts, and analytical techniques associated with macroeconomics. Students learn to understand the difference between growth and development, the reasons and impact of migration, the role of institutions (e.g. properte and use rights), development cooperation and international trade. The

students are able to analyze empirical evidence on economic development and to critically read the literature in the field of economic development.

Teaching and Learning Methods:
The lecture and the seminar will be done by PowerPoint. In addition, current examples from newspapers and journals will be integrated into the lectures. In the seminar, the students research current case studies linked to the theories and concepts presented in the lecture. These case studies are then individually and / or groupwise discussed and questioned from different perspectives together with the students. Web lectures by internationally renowned experts and researchers will be integrated into the lecture.

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

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

Responsible for Module:
Anja Faße

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

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

Module Description

CS0114: International Trade | International Trade

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental and resource economy. Important international examples will be explained. Type of examination: written, no additional tools allowed, duration of examination: 60 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Micro- and Macroeconomics

Content:
Basics of trade theory, such as Gains of Trade are deepened. Effects of customs duties and non-tariff trade barriers, such as environmental standards are presented. It deals with the concept of Pollution Haven and Race to the Bottom. The World Trade Organization and its role in international trade will be presented and discussed on the basis of current trade agreements and conflicts.
In addition, the lecture gives an overview of the effects of trade on international resources consumption. In doing so, empirical trade models (e.g., Gravity Model) are used for clarification.

Intended Learning Outcomes:
Students develop an understanding of theories and empirical methods used in the analysis of international trade. They know how trade policy affects the competitiveness and well-being of society and can apply these methods to the core issues of the globalization debate and sustainable trade.

Teaching and Learning Methods:
The lecture and the seminar will be done by PowerPoint. In addition, current examples of trade policy from the media and journals will be integrated into the lectures. In the seminar, the students research current case studies on the theories and concepts presented in the lecture. These case studies are then individually and / or groupwise discussed and questioned from different perspectives together with the students. Empirical trade models are used and discussed.

Media:
Presentations, slide scripts, Articles

Reading List:
Krugman, Obstfeld (2016) International Economics: Theory and Policy, Global Edition; Michael Todaro, Stephen Smith (2012). Economic Development, Pearson.

Responsible for Module:
Prof. Dr. Anja Faße

Courses (Type of course, Weekly hours per semester), Instructor:
International Trade (Seminar) (Seminar, 2 SWS)
Faße A [L], Faße A

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

Module Description

CS0118: Environmental Accounting in Economics and Sustainability Sciences | Environmental Accounting in Economics and Sustainability Sciences

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination will be given in the form of a written examination. The students should be able to evaluate and justify general and detailed theories, methods and concepts of the environmental accounting in economics. Example problems will have to be explained, solved and discussed. Type of examination: written, no additional tools allowed, duration of examination: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Micro- and Macroeconomics, Advanced Sustainability and Life Cycle Assessment

Content:
Fundamentals of the national accounts (input-output analysis) and the extension to environmental and social accounts (NAMEA, Social Accounting matrix). Integration of environmental accounts through physical and monetary environmental accounts and their advantages and disadvantages. Execution of multiplier analyzes with Excel. Use of input-output analysis and its environmental extensions for material flow analysis. Dynamic and multi-regional input-output approaches and hybrid Life Cycle Assessment.

Intended Learning Outcomes:
After the module, students will be able to understand and develop the system of national accounts and the integration of environmental accounts (monetary and physical) at national and regional level. They are able to perform and interpret a multiplier analysis. They use advanced methods of input-output analysis to solve problems in material flow analysis.

Teaching and Learning Methods:
The lecture and the tutorial will be done by Powerpoint and Excel. In addition, current examples from scientific journals and data sets will be integrated into the lectures. For advanced examples the use of a mathematical software suite such as Matlab and input-output as well as life cycle inventory databases is intended. These case studies are then analyzed and discussed individually and / or in groups from different perspectives together by the students.

Media:
Presentations, slide scripts, Articles

Reading List:
Taylor (2008): Village Economies: The Design, Estimation, and Use of Villagewide Economic Models. Cambridge University Press; Anguita & Wagner (2010): Environmental Social Accounting Matrices: Theory and Applications, Routledge. Brunner/Rechberger (2017): Handbook of Material Flow Analysis, CRC Press; Miller/Blair (2009): Input-output Analysis: foundations and extensions, Cambridge University Press; and recent journal articles (to be announced in the lectures)

Responsible for Module:
Anja Faße

Courses (Type of course, Weekly hours per semester), Instructor:
Environmental Accounting in Economics and Sustainability Sciences (Exercise) (Vorlesung mit integrierten Übungen, 2 SWS)
Faße A [L], Faße A

Environmental Accounting in Economics and Sustainability Sciences (Lecture) (Vorlesung, 2 SWS)
Faße A [L], Faße A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0119: Behavioral Public Economics | Behavioral Public Economics

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination will be given in the form of a written examination. The students should be able to describe theories, methods and concepts of Behavioral Public Economics. Students should be able to explain important examples from the academic literature. Type of examination: written, calculators are allowed, no additional tools allowed, duration of examination: 90 minutes

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Microeconomics, Advanced Microeconomics

Content:
In this course combines public economics with recent contributions of behavioral economics. Students will learn how to apply findings from behavioral economics to the public sector. This course will combine standard models from text books with recent academic papers. We will cover classic theories, their behavioral extensions, and empirical studies. Cover topics will be:
- Welfare Analysis
- Taxation
- Public Goods / Externalities
- Political Economy (Politicians and Voting)
- Public Policy (Savings, Poverty, Health, Environment)

Intended Learning Outcomes:
After attending the module, students will understand current topics in Public Economics and know the relevant insight from behavioral economics. They are capable of applying economic theory to analyze current problems and they can reference the relevant empirical evidence. Students can

analyze and evaluate policy proposals. Based on existing examples they can design and discuss their own policy interventions.

Teaching and Learning Methods:
The lecture will be mostly done by presentations. In addition, articles from newspapers and journals are integrated into the lectures. Together with the lecturer, students will study the content and methods of the academic papers. In the exercises, students will practice solving the learned models. This will either be done jointly on the blackboard or as work in smaller groups. Classroom experiments are carried out for selected topics.

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

Reading List:
Atkinson, A. and Stiglitz, J. (1980), Lectures on Public Economics, McGraw-Hill; reprinted by Princeton University Press (2015).
Gruber, J. (2016) Public Finance and Public Policy, 5th edition, Worth Publishers.
Additional references of academic papers

Responsible for Module:
Sebastian Georg

Courses (Type of course, Weekly hours per semester), Instructor:
Behavioral Public Economics (Exercise) (Übung, 2 SWS)
Goerg S [L], Goerg S

Behavioral Public Economics (Lecture) (Vorlesung, 2 SWS)
Goerg S [L], Goerg S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0176: Service Operations | Service Operations

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
• The examination is carried out in the form of a written test. This should demonstrate that the students can formulate quantitative decision models in the service sector and solve them with suitable methods.
• Type of examination: written
• Exam duration: 60 minutes

Repeat Examination:

(Recommended) Prerequisites:
Content of the module „Operations Research“ is recommended

Content:
• The basic concepts are presented with slide-based lectures. The quantitative models and methods are presented and illustrated by means of examples. Practical applications of service management, e.g. for hospitals, airlines, retail or the service sector.
• These contents form the basis for a critical consideration from a theoretical-conceptual and practical-application-oriented point of view. Current research papers and system-supported case studies are used for this purpose.
• In addition to an introduction to service management, the course also includes location planning, quality management, benchmarking, methods of process optimization, personnel planning, inventory planning and revenue management in the service sector.

Intended Learning Outcomes:
• The students get to know quantitative methods of operations management in the service sector and their application in practice.

• The students learn and understand the basic models and methods for service operations management (especially quality and process management as well as capacity planning) and revenue management (especially price differentiation, capacity control, overbooking control and dynamic pricing). It is also about getting to know the possibilities and limits of the models for use in practice.
• The students deepen their knowledge with regard to the modeling and solving of decision problems in the decision fields mentioned above.

Teaching and Learning Methods:
The basic concepts are presented with slide-based lectures. The quantitative models and methods are presented and illustrated by means of exercise examples, including practical applications in service management, e.g. for hospitals, airlines, retail or in general in the service sector. These contents form the basis for a critical consideration from a theoretical-conceptual and practical-application-oriented point of view. Current research papers, case studies and textbooks are used as the basis for this.

Media:
Presentations, black board work, exercise sheets

Reading List:
• Fitzsimmons, J.A. und M.J. Fitzsimmons: Service Management – Operations, Strategy, and Information Technology. McGraw Hill, New York, 3. Auflage, 2001.
• Klein, R. und C. Steinhardt (2008): Revenue Management – Grundlagen und Mathematische Methoden, Berlin/Heidelberg, Springer
• Talluri, K.T. und G.J. van Ryzin (2005): Theory and Practice of Revenue Management, Boston, Springer

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Service Operations (Lecture) (Vorlesung, 2 SWS)
Hübner A [L], Hübner A

Service Operations (Exercise) (Übung, 2 SWS)
Hübner A [L], Hübner A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0177: Discrete Event Simulation | Discrete Event Simulation

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
The examination consists of two individual tasks and a project work. The individual work is done as homework and is composed as follows:
• R-Statistics homework (10 % of the evaluation)
• AnyLogic homework (10 % of the evaluation)

The project work serves to evaluate the understanding in handling and application of simulations. For the project work the participants receive a randomly assigned extensive fictitious simulation problem. The project work consists of the presentation of the project plan, a project report, an oral presentation of 20 min and a discussion time of 10 min.

The evaluation of the project work is based on the following criteria:
• presentation of the project plan (10 % of the evaluation)
• written documentation of the project work (50% of the evaluation)
• presentation and discussion of the project work (20% of the evaluation)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in mathematics and statistics, especially in probability theory and probability distributions as well as descriptive and inductive statistics

Content:
• Basics of simulation
• Steps in a Simulation Study
• Conceptual Modeling
• Introduction to ARIS: Representation of processes using event-driven process chains

• Data collection and modeling of input data
• Introduction to R: Analysis of distributions
• Modeling and implementation of simulation models
• Introduction to simulation software (e.g. AnyLogic) and basic as well as advanced simulation techniques
• Visualization of simulations
• Verification, Validation and Calibration of a simulation
• Methods for determining the simulation setting
• Statistical methods for the analysis of simulation results

Intended Learning Outcomes:
Students
• apply their knowledge of probability theory and probability distributions
• are able to analyze production and logistic systems, represent processes and design proposals for optimization.
• apply the necessary methodological knowledge for the independent execution of simulation studies.
• are able to apply simulation software such as AnyLogic practically.
• can present results of a simulation study and derive concrete recommendations for action from their analyses.

Teaching and Learning Methods:
The module consists of a lecture and an exercise, which take place weekly. In the lecture, the contents are derived together with the participants. The exercise repeats the lecture contents with examples and deepens core concepts through independent simulation and computational studies of selected problems. The students are supported in solving the exercises by the tutors.

Media:
Presentations, cases and solutions

Reading List:
• Kelton, W. D., R. P. Sadowski, and D. T. Sturrock, Simulation with Arena, 3. Aufl., Boston (McGraw-Hill) 2003.
• Law, A. M. and W. D. Kelton, Simulation Modeling and Analysis, 4. Ed., Boston (McGraw-Hill) 2007.

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Discrete Event Simulation (Exercise) (Übung, 2 SWS)
Hübner A [L], Schäfer F

Discrete Event Simulation (Lecture) (Vorlesung, 2 SWS)
Hübner A [L], Schäfer F
For further information in this module, please click campus.tum.de or here.

Module Description

CS0238: Environmental Behavior and Support for Climate Policies | Environmental Behavior and Support for Climate Policies

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Achievement of desired learning objectives shall be verified in a term paper (max. 10 pages) and an oral presentation in a group. The students will implement their own online survey and present the findings in the context of the relevant literature in a group presentation (each student has to present 10 minutes). The oral presentation shall be assessed according to content and rhetoric aspects. The term paper is written individually and summarizes the relevant literature, empirical method, data, and key findings. Weighting: Term paper 2, Presentation 1.

Repeat Examination:

(Recommended) Prerequisites:

Content:
The successful transition from a fossil fuel economy to a more bio-based and sustainable circular economy requires pro-environmental behavior and public support for long-term climate policies (e.g., climate neutrality by 2050). This course aims to explain the factors of environmental behavior and why citizens support or reject climate change polices. Based on recent empirical findings from psychology and economics, the following factors influencing behavior and policy support are discussed:

- socio-psychological factors and climate change perception (e.g., political orientation, environmental values, risk perception, emotions, etc.),
- the perception of climate policy and design (e.g., perceived costs, perceived fairness, perceived effectiveness, etc.), and
- contextual factors (e.g., social norms, participations, economic and geographical aspects).

The course consists of a lecture that gives an overview of the factors that influence environmental behavior and public support for climate policies. It will also review methodological questions relevant for (online) surveys. In the integrated exercises students will be trained to implement online surveys and experiments. Students will be assigned to groups and conduct their own online survey and investigate factors that influence pro-environmental behavior and the support for climate policies.

Intended Learning Outcomes:
After attending the module, students will understand current topics in the psychology and economics of climate change. They are capable of applying online surveys to analyze the support or rejection towards climate policies and they can reference the relevant empirical evidence. Students can analyze the collected data with the appropriate statistical models. Students learn how to present scientific results in the public. In addition, students learn to write a term paper according to scientific standards.

Teaching and Learning Methods:
The lecture will be mostly done by presentations. In addition, articles from newspapers and journals are integrated into the lectures. Together with the lecturer, students will study the content and methods of the academic papers. In the exercises, the students themselves conduct an online survey and analyze the collected data. The results of the online survey are then presented and discussed individually and / or in groups from different perspectives by the students. Students will reproduce what has been learned in a written work.

Media:
Presentations, Articles

Reading List:
Bibliography of scientific publications

Responsible for Module:
Andreas Pondorfer

Courses (Type of course, Weekly hours per semester), Instructor:
Climate Policies and Behaviour (Vorlesung mit integrierten Übungen, 4 SWS)
Pondorfer A [L], Pondorfer A
For further information in this module, please click campus.tum.de or here.

Module Description

CS0244: Inventory and Transportation Management | Inventory and Transportation Management

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Written exam: 60 minutes written exam on presentation, recommended readings, and case studies

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor Business administration; advanced knowledge of Mathematics, Statistics and Operations Research

Content:
The course covers decision-oriented aspects of logistics and discusses basic concepts, models, and methods for inventory management and transportation planning in supply chains. This course content provides the foundation for a critical examination of logistics systems from a theoretical and practical perspective.

Part A: Introduction
- Terminological Issues of Logistics Management
- Principles of Logistics Management

Part B: Inventory Management
- Basics of Inventory Management
- Lot Sizing
- Safety Stock
- Work-in-Process

Part C: Transportation Management

- Basic Methods for Transport Optimization
- Transportation Planning
- Packaging
- Shortest Rout Problems
- Traveling Salesman and Vehicle Routing

Intended Learning Outcomes:
The students:
- know the conceptual structure of inventory management and transportation planning and understand basic concepts, models, and methods that are applied in industry and logistics applications
- gain experience in the logistics using prevalent decision models, software systems and understand scope and limitations in supporting practical decision situations.
- hone their skills with respect to modeling and solving decision problems in logistics management.

Teaching and Learning Methods:
Lecture (theory), tutorials with group work and presentation

Media:
Seminaristic delivery using beamer, overhead projector, flipchart

Reading List:
Chopra/Meindl (2009): Supply Chain Management: Strategy, Planning, and Operation, Global Edition
Ghiani, G., Laporte, G., Musmanno R. (2013), Introduction to Logistics Systems Management, 2. edition, Wiley
Günther, H.O., Tempelmeier, H. (2020), Supply Chain Analytics
Silver, E. A., Pyke, D. F. und R. Peterson, Inventory Management and Production Planning and Scheduling, 3. edition, New York (Wiley) 1998.

Responsible for Module:
Alexander Hübner

Courses (Type of course, Weekly hours per semester), Instructor:
Inventory and Transportation Management (Lecture) (Vorlesung, 2 SWS)
Hübner A [L], Hübner A

Inventory and Transportation Management (Exercise) (Übung, 2 SWS)
Hübner A [L], Riesenegger L
For further information in this module, please click campus.tum.de or here.

Master's Thesis | Master's Thesis

Module Description

CS0173: Master's Thesis | Master's Thesis

Version of module description: Gültig ab summerterm 2021

Module Level:	Language:	Duration:	Frequency:
Credits:* 30	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Admission Requirements | Admission Requirements

Module Description

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

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
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], Doblinger C, Perlinger K
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab winterterm 2021/22

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

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

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

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

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

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

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

Learning activities: Literature research, (optional) group project

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

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

Responsible for Module:
Prof. Klaus Menrad

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

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

Module Description

CS0196: Sustainable Operations | Sustainable Operations

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
The 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:
Next semester

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

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

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

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

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

Media:
Presentations, Script

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

Responsible for Module:
Prof. Alexander Hübner

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
The 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

CS0192: Accounting | Accounting

Version of module description: Gültig ab winterterm 2021/22

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

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

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

Repeat Examination:
Next 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:

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

Module Description

CS0063: Microeconomics | Microeconomics [Micro I]

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
In the exam (written, 120 minutes) students should demonstrate their ability to adequately interpret 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:
Next semester

(Recommended) Prerequisites:

Content:
This course provides an introduction to basic concepts of microeconomics. It deals with the behaviour 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. 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. 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 - Übung am Campus Straubing (Übung, 2 SWS)
Drobner C, Goerg S

Economics I am Campus Straubing (Microeconomics) (Vorlesung, 2 SWS)
Goerg S
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab summerterm 2019

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

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

Description of Examination Method:
Written exam (90 minutes): Students have to solve problems from the thematic field of the module. They have to prove their ability to use the right vocabulary, apply their knowledge on life cycle and systems thinking, Material Flow Analysis and Life Cycle Assessment and in particular methods for the analysis and modelling of material and energy flows, data determination, uncertainty treatment and assessment of environmental impacts. Learning aids: pocket calculator.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The module contains units covering the following topics:
- Systems and life cycle thinking
- Material flow networks
- Material and energy flow balancing
- Material flow modelling
- Life Cycle Assessment
- Data determination
- Handling of data uncertainty
- Current trends and developments
- Software systems and data bases for material flow analysis and life cycle assessment
- Case studies

Intended Learning Outcomes:
The students use the concepts and tools of material flow analysis and life cycle assessment to analyse industrial metabolisms as well as products and services regarding their environmental impacts. Thus, they are able to gain a deeper understanding of their underlying material and energy flows and how they impact the environment. With these competencies development and improvement of systems, products and services can be supported, decision support delivered and communication with stakeholders aided.

Teaching and Learning Methods:
Format: lecture and (computer-based) exercises to introduce the content, to repeat and deepen the understanding as well as practice individually and in groups.

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individual assignments and presentation
- Computer lab exercises using MFA and LCA software systems

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

Reading List:
Recommended reading:
- Baccini, P. & Brunner, P.H. (2012): Metabolism of the Anthroposphere: Analysis, Evaluation, Design. MIT Press.
- Brunner, P.H. & Rechberger, H. (2003): Material Flow Analysis. CRC Press.
- Curran, M.A. (2015): Life Cycle Assessment Student Handbook, Scrivener Publishing:
- Guinée, J.B. (2002): Handbook on life cycle assessment: operational guide to the ISO standards. Kluwer, Dordrecht.
- Hauschild, M.Z. & Huijbregts, M.A.J. (2015): Life Cycle Impact Assessment (LCA Compendium - The Complete World of Life Cycle Assessment), Springer.
- Klöpffer, W. & Grahl, B. (2014): Life Cycle Assessment (LCA), Wiley-VCH.

Responsible for Module:
Magnus Fröhling magnus.froehling@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Basics of Material Flow Analysis and Life Cycle Assessment (Lecture) (Vorlesung, 2 SWS)
Fröhling M [L], Fröhling M

Basics of Material Flow Analysis and Life Cycle Assessment (Exercise) (Übung, 2 SWS)
Fröhling M [L], Huber J
For further information in this module, please click campus.tum.de or here.

Module Description

CS0073: Circular Economy | Circular Economy [CEC]

Version of module description: Gültig ab summerterm 2019

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

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

Description of Examination Method:
Written exam (90 minutes): Students have to analyse and assess (simplified) circular economy concepts on a local, regional, national and global level and determination of starting points for an optimisation of these concepts with methods of material flow analysis, life cycle assessment and quantitative management approaches. In addition, they have to elaborate, assess and discuss business models in this field. In doing so, the students have to prove their ability to use the right vocabulary, and their knowledge on the motivation and key figures of circular economy.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The module contains units covering the following topics:
- Necessity and importance of closed material cycles
- Product and material life cycles, their prolongation and extension
- Thermodynamic principles and their consequences for a circular economy
- Local material cycles and industrial symbiosis
- Regional material cycles
- Global material cycles
- Circular economy concepts for renewable resources
- Circular economy concepts for non-renewable resources
- Emerging business models in a circular economy

Intended Learning Outcomes:
Student have a basics understanding of the concepts of circular economy. They discuss the aim of closing material loops on the global, national and regional level beyond the current situation, technological and organisational options, boundaries set by chemical and physical laws and regulatory frameworks. They are able to identify business opportunities, develop and discuss new innovative business models.

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

Teaching / learning methods:
- Media-assisted presentations
- Group work / case studies with presentation
- Individual assignments and presentation

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

Reading List:
Recommended reading:
- Ayres, Robert U. (2002): A handbook of industrial ecology
- Baccini, Peter (1991): Metabolism of the Anthroposphere, Springer
- Baker-Brown, Duncan (2017): The re-use atlas a designer's guide towards a circular economy
- Charter, Martin (2019): Designing for the circular economy, Routeledge
- De Angelis, Roberta (2018): Business Models in the Circular Economy: Concepts, Examples and Theory, Palgrave Macmillan
- Franco-García, María-Laura ; Carpio-Aguilar, Jorge Carlos ; Bressers, Hans: Towards Zero Waste: Circular Eocnomy Boost, Waste to Resources, Springer
- Larsson, Mats (2018): Circular Business Models: Developing a Sustainable Future
- Schaub, Georg; Turek, Thomas (2016):
- Energy Flows, Material Cycles and Global Development: a Process Engineering Approach to the Earth System, Springer
- Webster, Ken (2017): The Circular Economy - A Wealth of Flows, Ellen MacArthur Foundation Publishing

Responsible for Module:
Magnus Fröhling magnus.froehling@tum.de

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

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

Alphabetical Index

A

B

C

D

E

F

G

I

M

O

P

R

S

W